



# ARCHIVES OF OTOLARYNGOLOGY

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MARCH 1948

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## AUDIOMETRIC STUDIES OF THE RESIDUAL HEARING OF PUPILS OF RIO DE JANEIRO NATIONAL INSTITUTE FOR THE DEAF

I Auditory Acuity of Deaf Children

ARMANDO PAIVA LACERDA, M D

Director of the Instituto Nacional de Surdos Mudos do Rio de Janeiro

AND

ALFREDO EUGENIO VERVLOET, M D

RIO DE JANEIRO, BRAZIL

THE STUDY of the auditory acuity of deaf children based on new ideas and methods of otologic research has brought out different and interesting phases which are of scientific and pedagogic interest

It has given valuable information as to the characteristics of the residual hearing, and it has also suggested many possibilities of greater usefulness of the remnants of hearing

The problems of deafness—in a secondary position for so many years—are now, in the last two decades, being studied by a large body of specialists, this is to be attributed in great part to new developments of the physics of sound. Increasing interest in this subject is noticed in scientific and clinical investigations. These have within their scope such problems as the recognition of new etiologic factors and the diagnosis, the prevention and, finally, the treatment of diseases of the ear. Adequate methods of instruction, auricular prosthesis and rational therapeutics have been put in practice. All these subjects are closely associated with modern acoustics and the speedy march of today's science

In the second half of the nineteenth century men from different countries, European physicians, physiologists and aurists, spent a lifetime endeavoring to show the importance of knowledge of the normal and the pathologic physiology of hearing. Their efforts, although they were based on accurate research and experiments of outstanding clinical value, were not always successful in making converts who would pursue the same studies. Of those active during this period, two remarkable scientists should be mentioned. Their meticulous examinations of the residual hearing of deaf children went beyond what might be expected. The work done by Urbantschitsch and Bezold to show the importance of acoustic training of the deaf and the existence of isolated tonal

zones, termed "tone islands," is of immense help to science and to otology in particular. They, together with Helmholtz, have established basic rules for the future development of acoustics and physiology, both applied to the pedagogy of the deaf. Urbantschitsch is credited with new orientation of the acoustic training of deafened adults and deaf children, hence, the extensive use of the acoustic method in some European schools, and the improvement of the therapeutics of certain types of acquired deafness. Scientists who came immediately after, made a few innovations, but the basic principles have remained the same.

Great progress has been made in recent years in the fields of physical and applied acoustics. Noteworthy is the work done by the North Americans, which has enabled otologists to make better experimental studies of deaf children. This fact has contributed much to the keen attention that has been devoted lately to this kind of experimentation. The methods of measurement of hearing, as well as the means of sound transmission and sound amplification, now in use show a higher percentage of children bearing residual hearing. As a result, otologists are at better advantage in pedagogic training and are able to achieve better stimulation of the ear and to employ a more accurate technic in auricular instruction.

With the introduction of audiometry based on experimental methods and on the Weber-Fechner psychologic law—the one applied to sensations—it was possible to make more accurate tests of auditory acuity. Many causes of errors associated with the old method were then eliminated. The measuring of the intensity of a tone at the threshold of audibility by the use of the decibel scale has become a scientific process by means of which the hearing capacity can be determined. The audiometric test not only helps one in diagnosing the pathologic condition of the ear but also informs one, in case of auditory loss, as to how accentuated it is. Together with the anamnesis and a careful examination of ear, nose and throat and a vestibular test, it gives valuable information as to the nature and the degree of the hearing impairment.

As shown, the audiometric process plays an important role in the determination of the normal or the pathologic condition of the ear. When it comes to the study of the deaf person's residual hearing, the same may be said. This is on account of a better as well as meticulous examination which that process made possible. When the audiometric characteristics of the hearing loss are recorded, together with the development of that loss, in the audiograms, the records obtained help greatly toward a better understanding of the pathologic condition. Yet, with the audiometric proofs, otologists are going to find signs or well defined phenomena which appear simultaneously with the progressive process of impairment, indications that the pathologic state of hearing is getting worse. Finally, the audiometric process makes possible a qualitative and quantitative study of the residual hearing.

and favors a better comparison of the curves representing the hearing by air and bone conduction. This is essential for a good clinical and experimental appreciation of deaf children and for the study and diagnosis of perceptive deafness.

#### CHARACTERISTICS OF THE RESIDUAL HEARING OF DEAF CHILDREN BY AIR AND BONE CONDUCTION

The study of the residual hearing of deaf children may be conducted either by means of normal acoumetric tests or through the use of the audiometer.

The measurement of hearing by bone conduction becomes as important as that of hearing by air conduction with any of the aforementioned methods, for it is known that the bone conduction is closely related to the mechanism of the sensory organ and to the auditory nerve.

Since the first experiments with children of the Rio de Janeiro Institute for the Deaf, undertaken in 1931 by Henrique Mercaldo, M D, head of the clinical department—with the use of the instruments he could afford at that time—it was noticed that in the majority of cases hearing by bone conduction was not evident or was only observed at the lower tones of the tuning forks, namely, 128 and 256 double vibrations. At the same time he was having fair results from tests of hearing by air conduction, recording thresholds for frequencies from 512 up to 2048 double vibrations, provided adequate intensities were used. The perception of the tone of the last fork usually occurred with the Galton whistle at the lower limits of its scale. It is worth mentioning that a great number of children heard bells of different tonalities.

In only a few cases was the bone conduction curve as extensive as the air conduction curve while the situation in which the former was longer than the latter was most uncommon.

Although the difference observed was attributed to severe damage of the nerve type, it seemed rather peculiar that air conduction was more preserved than bone conduction, for it was the general understanding that the auditory loss by bone conduction should be followed by the loss by air conduction.

Among the publications of that time one finds references to the use of bone conduction in teaching deaf children<sup>1</sup>. Not only the results of the early acoumetric tests but the results of experiments, as will be shown later, did not agree with that, not in a single case.

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1 Malherbe, A., Vilenski, R., and Herman, N. Expose des recherches entreprises à l'Institution Nationale des Sourds-Muets de Paris. Concernant les reliquats auditifs decelés chez les Sourds-Muets et la possibilité d'entreprendre leur utilisation pédagogique notamment par voie osseuse, Paris, Institution Nationale des Sourds-Muets de Paris, 1935. Gilder, R. P., and Hopkins, L. A. The Importance of Auditory Function Studies in the Educational Program for the Auditorially Handicapped Child, *Volta Rev.* 38 69-70 (Feb.) 1936.



The cases in which we observed bone conduction thresholds long enough to permit pedagogic training were rare. When this happened, equal or better conditions were verified by air conduction.

We started our training, using the spoken voice, without any hearing aids. Later we introduced in our auricular classes the modern amplifiers of sound. With the help of this amplification, the children receive by air conduction the teacher's voice, as well as any other auditory stimuli produced in the class room. And the results of this auricular teaching have been encouraging to the present time. The classes are under the leadership of Sr. J. B. Silvado, who made especial inquiries with regard to the subject during his trip to the United States in 1938.

But, what finally marked a new era in our work was the introduction of the audiometric tests, which have enabled us to make a more accurate analysis of deafness. Using a Western Electric 6 A Audiometer, fully equipped, a Pilling-Witting auditory masker and a soundproof room, we started a new phase of research on the auditory acuity of pupils, studying the problem in a qualitative as well as in a quantitative way.

The hearing of 241 children was examined with respect to both air and bone conduction. There were boys and girls, their ages ranging from 7 to 21 years.

Many of the children gave satisfactory answers which were recorded, the responses of others were not reliable. In the first group we find those who acquired the impairment after birth and also those who were born deaf but had some residual hearing and thus were able to recognize the acoustic impressions. In the second group, besides the children whose impairment could be attributed to a psychologic disturbance, there were children who, on account of a marked degree of impairment, had poor conception of sound. The audiograms of these children, as well as those of the younger ones, were taken into consideration only after they had been through a training program which enabled them to recognize the sound so that their answers might be regarded as reliable.

The children who after that did not give reliable responses to the audiometric tests were eliminated. Their records have therefore been excluded from further consideration in this study. With those records excluded, the total material which serves as a basis for this analysis is composed of 200 audiograms. The difficulty in questioning the subjects increased with decreasing age, so that it became impossible to record the answers of the ones less than 7 years.

The audiometric tests, being more accurate, enabled us to make a far better comparative study between air and bone conduction. The 379 curves obtained for hearing by air conduction against the 233 for hearing by bone conduction are in themselves a notable proof of the

better perception with the former. The air conduction curves have also a wider range, which was a result of the greater number of auditory perceptions. This is important from the pedagogic standpoint, since it is considered in choosing the hearing aids that are to be utilized in the auricular classes. On the other hand, the bone conduction, giving better information of the cochlear function, is useful in arriving at the diagnosis and the prognosis of deaf-mutism. It is opportune to emphasize here that there was not observed any discrepancy between the audiometric records of hearing by bone and by air conduction related to the sexes.

Only in 5 audiograms, that is, 2.5 per cent, was no mark registered at any frequency of the audiometric range either for bone or for air conduction, these audiograms indicating total loss of serviceable hearing. In all the cases in which a total loss of hearing by air conduction was observed the tests of hearing by bone conduction gave negative results. On the other hand, there was not a single case in which bone conduction was picked up alone. The very reduced number of those who did not experience any sensation with the auditory stimuli draws one's attention.

The following statistical data on the threshold values of hearing by bone and air conduction of our children give a clear picture of the type of auditory loss. They present some deviations from the ones published in the *ARCHIVES OF OTOLARYNGOLOGY* by Walter Hughson, Antonio Ciocco and Carol Palmer in their "Studies of Pupils of the Pennsylvania School for the Deaf"<sup>2</sup>. The main difference lies in the fact that our median auditory threshold curves for air conduction were wider and our median curves for bone conduction shorter. Yet, using a different procedure, we separated the results of each ear for better comparison of the thresholds of hearing by bone and air conduction.

We have utilized the same statistical constants. The first quartile expresses the auditory threshold of 25 per cent of the ears which heard best, the median expresses the auditory threshold of 50 per cent of the ears with the best hearing. If the first quartile is omitted (indicated by a dash), it means that less than 25 per cent of the ears were able to hear the tone. In a similar manner, if a median is omitted, it means that less than 50 per cent of the ears were able to perceive the tone at the greatest intensity possible to the audiometer. From the data obtained for every audiometric frequency, tables and charts were constructed for residual hearing by bone and by air conduction. The first quartile and median auditory thresholds of the right and the left ears of those children are shown in charts 1 and 2.

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<sup>2</sup> Hughson, W., Ciocco, A., and Palmer, C. Studies of Pupils of the Pennsylvania School for the Deaf. Auditory Acuity, *Arch Otolaryng* 29 403-416 (March) 1939.

Frequencies 256 and 512 were the only ones heard by 25 per cent of the children by bone conduction, on the other hand, all the tones of the audiometric range but the one of 8,192 cycles were perceived by 25 per cent or more by air conduction, as shown in table 1. Similarly, as shown in table 2, frequencies from 128 to 4096 and 8192 were heard

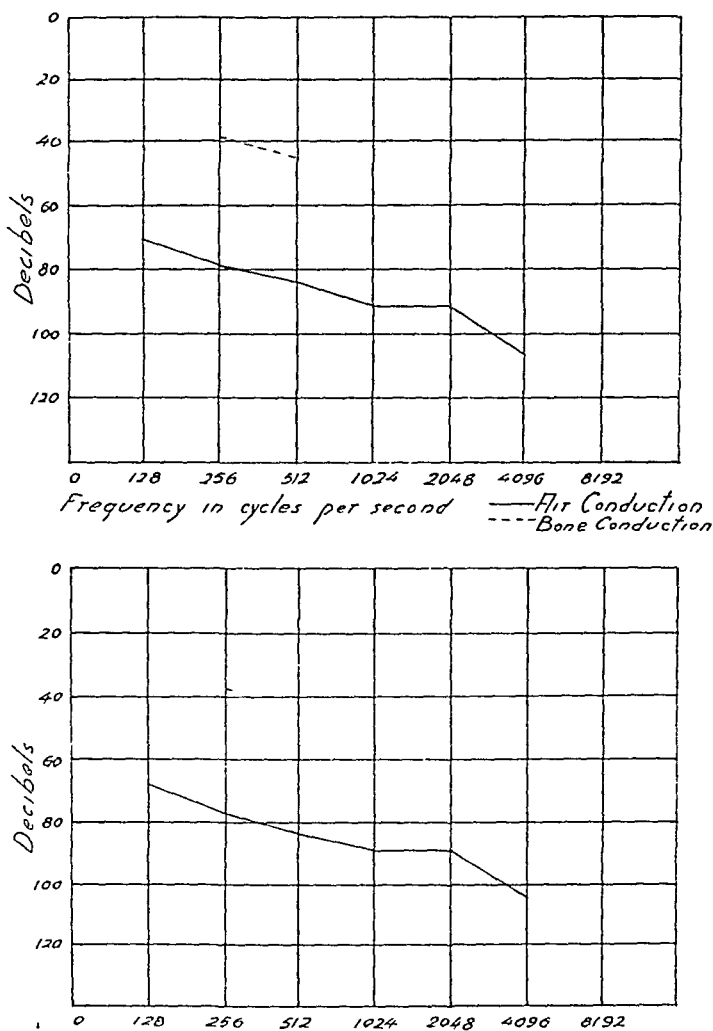


Chart 1—The first quartile threshold curves for the right and the left ears of deaf children who had residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ears, lower part, left ears.

by less than 50 per cent by air conduction, while the cycles 256 and 512 were the only ones that 50 per cent or more discerned by bone conduction.

Examining the first quartile and the median auditory thresholds, one notices that the auditory loss is about the same in the right and the left ears, by air or by bone conduction. An exception is made of the median for air conduction of the right ears, a more pronounced depression is seen at 1024 cycles.

One notices that the first quartile thresholds by air conduction, the data on which are arranged from the better to the worse ears, have a wider frequency range and are situated at more convenient levels than the median, as illustrated by charts 1 and 2. The latter shows better the general aspect, the curve for air conduction thresholds being

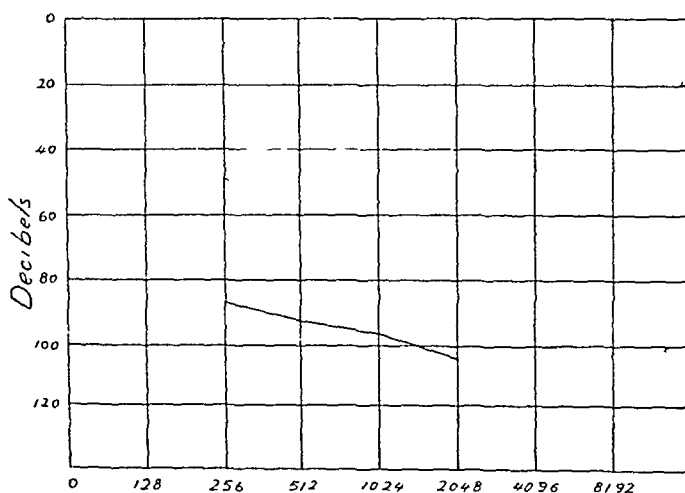
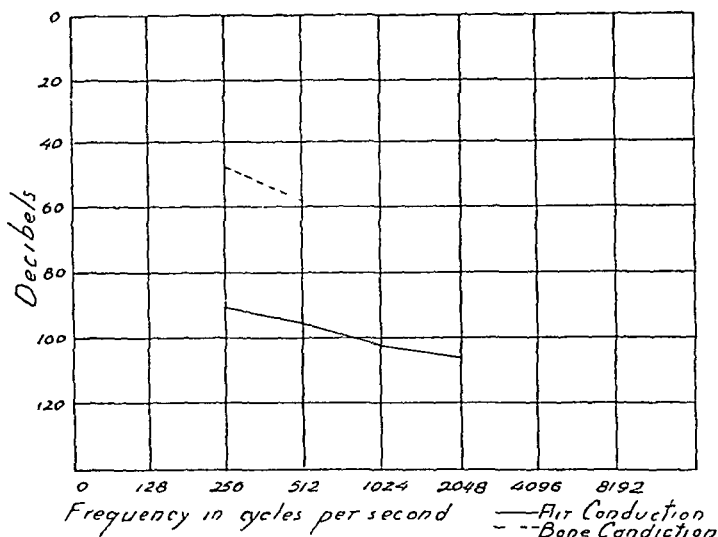


Chart 2—The median threshold curves for the right and the left ears of deaf children who had residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ears, lower part, left ears.

less wide, and that for bone conduction thresholds as wide as the one of the first quartile but at higher levels than the latter. This is an indication that the marks, or thresholds, are concentrated at higher intensities mainly by bone conduction. Besides, it may be noted that the air conduction curve of the first quartile covers a range of frequencies from 128 to 4096 cycles, and that the curve of the median thresholds

goes only from 256 to 2048 cycles. The bone conduction curve extends from 256 to 512 cycles, whether of the first quartile or of the median, though at different levels.

The purpose of table 3 and chart 3 is to make possible a better study of the children's hearing by air and by bone conduction, in both ears. The whole picture of all the individual observations made over the frequency range is shown, including the ones that were excluded from the first quartile and the median. In chart 3 the difference between the air and bone conduction curves shows up better. Noteworthy is

TABLE 1—*The First Quartile for the Right and the Left Ears of Deafened Children Who Had Residual Hearing of Air-Conducted and Bone-Conducted Frequencies*

Frequency in Cycles per Second	Right Ear		Left Ear	
	Air Conduction	Bone Conduction	Air Conduction	Bone Conduction
128	71 36	—	67 78	—
256	78 67	38 95	77 94	38 33
512	83 75	45 45	83 00	46 00
1024	91 04	—	89 47	—
2048	91 25	—	89 44	—
4096	106 25	—	104 83	—
8192	—	—	—	—

TABLE 2—*The Median for the Right and the Left Ears of Deafened Children Who Had Residual Hearing of Air-Conducted and Bone-Conducted Frequencies*

Frequency in Cycles per Second	Right Ear		Left Ear	
	Air Conduction	Bone Conduction	Air Conduction	Bone Conduction
128	—	—	—	—
256	88 88	49 37	87 42	49 08
512	94 10	59 17	93 30	59 75
1024	101 19	—	95 88	—
2048	105 28	—	105 34	—
4096	—	—	—	—
8192	—	—	—	—

the small number of observations at 128 cycles, as well as the abrupt change starting at 2048 cycles by air conduction and at 512 cycles by bone conduction. This shows that the tones were not perceived by most of the children at the maximum intensity.

In all the diagrams one notices a general tendency for the disappearance of perception, or an abrupt change in the curves, at the lowest tone and at the higher ones, which is more pronounced in the charts for general measurements. Bone conduction curves shorter than air conduction curves are also noticed.

These results from the analysis of the children's residual hearing reveal the presence of nerve, or perceptive, deafness, as described by so many different authors.

The curves shown characterize better this type of deafness because they are based on audiometric tests of deaf children, in whom an advanced stage of the pathologic process is responsible for the perceptive deafness. This type of auditory loss is a consequence of degenerative or atrophic lesions of the nerve and the sensory organ, or only of

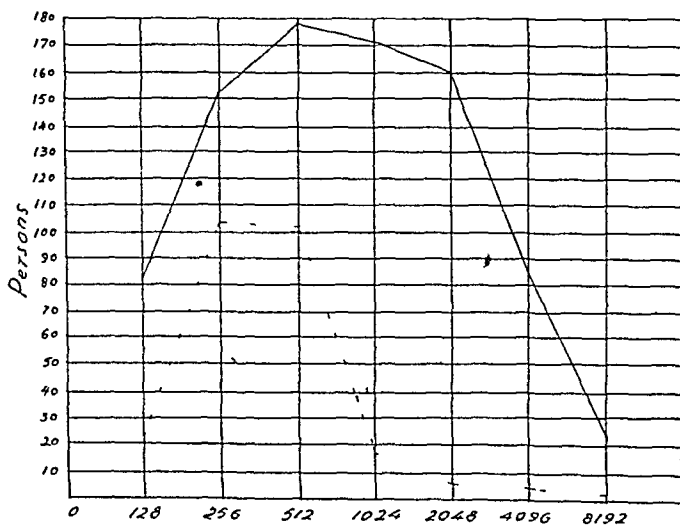
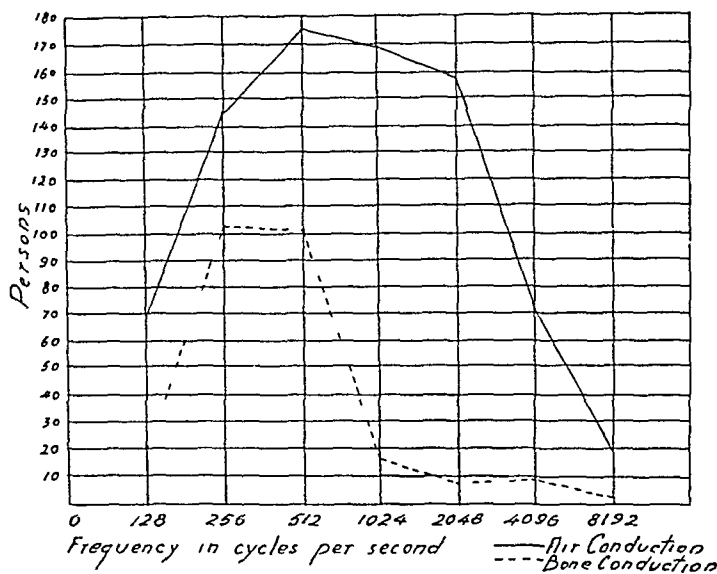


Chart 3—Comparative curves of the numbers of children with residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ear; lower part, left ear.

the latter. These injuries, the cause of profound deafness, may have originated as congenital lesions or may have been acquired in the first years of life.

Of the 200 children for whom there is a report of the age of onset of the impairment, 70 per cent were said to have been born deaf, there-

fore, they had congenital or constitutional lesions Syphilis (36 per cent), hereditary deaf-mutism (7.5 per cent) and alcoholism (3 per cent) were most frequently stated to have been the causes of the deafness The cause was regarded as obscure in 23.5 per cent of the children

The percentage of those who acquired the impairment after birth is about 30 per cent

The differences between the children's audiograms of the two groups are not regarded as significant This strengthens the suggestion made by the North American authors "that the pathologic mechanism has been the same in children who suffered marked loss of hearing as in the ones with a congenital defect"

However, Fischer and Wolfson<sup>3</sup> are inclined to accept that "deafness with eventual remnants of hearing (tone islands), associated with

TABLE 3—Numbers of Cases of Deafness in Which Auditory Thresholds Were Established for Air-Conducted and Bone-Conducted Frequencies

Frequency in Cycles per Second	Right Ear Number of Cases				Left Ear Number of Cases			
	Air Conduction		Bone Conduction		Air Conduction		Bone Conduction	
	No	%	No	%	No	%	No	%
128	67	8.32	20	7.66	82	9.58	22	8.53
256	145	18.01	103	39.47	153	17.87	104	40.32
512	176	21.87	102	39.03	178	20.80	101	39.11
1024	169	20.99	16	6.13	171	19.98	17	6.60
2048	153	19.63	8	3.07	160	18.69	6	2.33
4096	71	8.82	9	3.45	88	10.23	5	1.94
8192	19	2.36	3	1.14	24	2.80	3	1.17
Total	805	100.00	261	100.00	806	100.00	258	100.00

normal labyrinthine function, points rather to the heredo-degenerative type A condition in which there is a complete loss of hearing and of labyrinthine function favors more the diagnosis of acquired deaf-mutism"

Among the 59 children who presumably acquired their difficulty of hearing after birth, the disease most frequently stated to have been the cause of the deafness was injury of the head (7 per cent) Next in order came the different forms of meningitis (5 per cent), measles (4 per cent) and epidemic cerebrospinal meningitis (3 per cent) With less frequency, the stated causes include diphtheria (1.5 per cent), malaria (1 per cent), pneumonia (1 per cent), paratyphoid fever (1 per cent), scarlet fever, typhoid, infantile paralysis and obstetric traumatism, which occurred in single cases The cause was regarded as obscure in 4 per cent of the children

We failed to establish any correlation between the etiologic factors and the audiometric curves At first, we thought that more extensive

<sup>3</sup> Fischer, J, and Wolfson, L. E. The Inner Ear, New York, Grune & Stratton, Inc, 1943, p. 317

curves for bone and air conduction were associated with syphilis, and the less extensive, with epidemic cerebrospinal meningitis. Later it was verified that these diseases presented other types of audiograms, also. On the other hand, the curves aforementioned were connected with other diseases. No audiogram was obtained that could be said to be characteristic of a certain etiologic factor. We agree with the North American authors when they say that "there is apparently no association between auditory thresholds and stated causes of deafness." It is the opinion of some authors that no relation can be found between the thresholds and the lesions situated in the cochlea and in the auditory nerve.

That has been the opinion of Bing.<sup>4</sup> "It is rather difficult to establish in any human being a clearcut demarcation between the deafness due to damage of the sensory epithelium and that caused when the auditory nerve is injured." His explanation was "If the peripheral endings of the nerve are more influenced by infectious or traumatic processes, on the other hand, there are certain morbid causes such as tuberculosis, syphilis and scarlet fever, which can cause either labyrinthitis or neuritis." He proceeded "The acoumetric method used in the diagnosis of nerve deafness, unfortunately does not give accurate knowledge of the location of the pathologic process in the perceptive apparatus—organ of Corti, auditory nerve, nucleus or cortical fibers."

However, Crowe<sup>5</sup> mentioned two practical applications of histologic study in cases of nerve deafness.

"When the loss of hearing begins at 256 or 512 vibrations and increases gradually toward the higher tones, the lesion is atrophy of the cochlear nerve supplying the basal turn of the cochlea, and the organ of Corti is not affected. When the audiogram shows an abrupt or sharply localized impairment of perception for high tones, both the nerve and the organ of Corti in the basal coil are atrophic."

For an accurate determination of the etiologic factors and the pathogenic diagnosis of nerve deafness, we have to make use of other factors given by anamnesis, the state of the pathologic process and the clinical symptoms. Those data can be obtained from deafened adults. But, when one is dealing with a deaf-mute child, such material is hard to obtain, since in most of the cases the deafness is due to congenital and hereditary factors or has an obscure cause. Sometimes, with children who presumably acquired deafness after birth, a case history may be given, but we cannot trust it for a precise diagnosis.

4 Bing, R., and Curchod, E. *Diagnostic topographique des lesions de l'encephale et de la moelle epiniere. Precis de localisations clinique des affections et traumatismes des centres nerveux*, Paris, G. Doin, 1921, pp. 140-141.

5 Crowe, cited by Shambaugh, G. E. *Chronic Progressive Deafness, Including Otosclerosis and Diseases of the Inner Ear*, Arch. Otolaryng. 30: 999-1036 (Dec.) 1939.



In practice the audiometric tests, as well as the other acoumetric tests, did not help much in locating the lesion in cases of nerve deafness. The same cannot be said concerning the conductive impairment, in locating a lesion in the middle ear or in differentiating it from a lesion of the nerve in the inner ear.

According to Stevens and Davis<sup>6</sup>

"the damage of the sensorial cells, nerve fibers and nerve centers, immediately connected with them, produces what has been variously designated as nerve deafness or perception deafness. Nerve deafness is not always due to the degeneration of the auditory nerve, but may result from degeneration of the hair-cells of the organ of Corti. Damage to the hair-cells is, however, physiologically equivalent to damage to the nerve."

Finally, the audiometric curves of these cases give the reader an idea of the functional disturbance due to the perceptive or nerve type of deafness. It is generally associated with the pathologic mechanisms resulting from the atrophic or degenerative lesions of the auditory nerve or sensory organs, and yet it is a process involving them.

#### "VANISHING PERCEPTION" OF AUDIOMETRIC TONES AND THEIR RELATION TO AUDITORY FATIGUE

The results at which we have arrived when dealing with the residual hearing characteristics of deaf children go much farther than has been shown so far.

The tests of the auditory acuity of deaf children made with the audiometer, which were carefully conducted, owing to the interest we had in establishing a quantitative and a qualitative relation between the hearing by bone and that by air conduction, guided us to the verification of some other facts of the utmost importance.

The test of bone conduction, because of the relation of the latter to the inner auditory mechanism and, moreover, because of the interesting results we were obtaining, attracted our attention from the very first experiments. This increasing interest contributed much to our establishing some essential features by study of our own observations.

Adding the facts already noted and the ones we shall present, we may divide the results of the audiometric tests of the hearing by bone conduction of deaf children into three main classes:

- 1 Those which could not be registered on the audiograms
- 2 Those which were recorded at some frequencies, mainly 256 and 512
- 3 Those which showed perception but of such a slight and transitory nature that recording was impossible

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<sup>6</sup> Stevens, S. S., and Davis, H. *Hearing: Its Psychology and Physiology*, New York, John Wiley & Sons, Inc., 1938, p. 288.

The results in classes 1 and 2 have been studied. Now we shall take the last class, which from the experimental standpoint is by far the most important. We shall first analyze the facts which led us to the conclusion that there was a very rapid auditory perception, and then go over the progressiveness of the impairment of the hearing of our patients, according to the consecutive tests they underwent.

From the beginning of our experiments we noticed how difficult it was in some cases to record frequencies which were heard in a peculiar way, too quickly and too inconstantly, though doubtless hearing was present. As the examinations continued, it was possible for us to make a careful and meticulous analysis of this fact, which was in complete disagreement with what was usually noticed in the study of the threshold of audibility. Because of its strange evanescent behavior, we decided to name this very special auditory phenomenon "vanishing perception" of the audiometric tone.

The first thing that strikes one's attention when facing phenomena of such a nature is the difficulty or rather the impossibility of recording auditory thresholds at the higher levels of intensity, contrary to what usually happens when the patient perceives any type of frequency. It is so rapid that we have failed to record it, though we have tried hard. Some of the children have reported that the sound first heard vanished, and others have the impression that the sound was suddenly interrupted.

This phenomenon observed in testing bone conduction also occurs with air conduction, though not so often. It has been noticed by air conduction in cases in which there was a marked degree of impairment and in which the auditory thresholds of other frequencies, if existent, were situated at higher levels of intensity (as shown in chart 4).

There are usually registered, for every frequency of the audiometric range, thresholds from the lower levels to the upper levels of intensity both by air and by bone conduction. The extreme marks are often observed in the bone conduction curves on deaf children's audiograms, where it is noticed that the thresholds are concentrated at or around the upper levels of intensity of bone conduction and at the frequencies 256 and 512, as shown by their auditory "median" (chart 2).

However, as to the "vanishing perception," we verified the impossibility of its being recorded at those upper levels of intensity where it is perceived, not to speak of the lower levels where it is not even observed. It is noticed only at the extreme level or at two or three levels situated right below this, and when we try to record this auditory sensation, the children have no response to it no matter how high the intensity is, contrary to what is commonly observed at the auditory threshold of a tone. This "transitory perception" lasts for a few seconds and is followed by a period of silence varying from one to three minutes.

or even more. Its reappearance occurs at the same levels and in the same fashion. After a variable but small number of manifestations, and sometimes after its first appearance, it is perceived no more. This is the reason why the frequency which was heard evanescently fails to be perceived immediately afterward, even with the maximum intensity being used, but is heard within some minutes, after a new trial. This process goes on a few times till the patient has no more perception.

To the evanescent characteristic—the most important one—we can add the inconstancy, that is, the frequency is not always perceived at the same level and after the same interval of time.

Thus proceeding, we may summarize the main features of the “vanishing perception” of audiometric tones as follows:

- (a) The hearing of audiometric tones by bone or by air conduction at high intensity levels is of short duration.
- (b) The sensation lasts a few seconds, a silent interval succeeds each of its appearances till there are no more responses.
- (c) It displays inconstancy or variability.
- (d) Recording it is an impossibility.

Another fact that drew our attention was its special preference for certain frequencies.

In the tests of bone conduction, as soon as the receiver is placed against the mastoid process an interesting phenomenon commonly occurs. Let us take a low and a high frequency, say, 128 and 1024, where a rapid perception is noticed twice or three times. If we now move over to the frequencies 256 and 512 perception of these can be recorded, while at the higher frequencies (2048) no auditory sensation is heard. This phenomenon is observed till the end of the experiment, that is, when no more perception is verified at 128 and 1024 cycles. These different results with the same persons and with the same tests reveal a different phenomenon, provided we have used a rigorous and consistent technic.

To observe the evanescent perception we employ different procedures—all leading to the same objective. To begin with, after placing the bone conduction receiver against the patient's mastoid process, we start the test with the usual technic, trying to keep as reference the intensity level corresponding to the threshold of the tone under test. As soon as a very quick perception is noticed and the difficulty of recording it is at the same time verified, we try to raise the intensity to its maximum, in order to make sure that the tone is not heard at this level. This will be the indication that the “evanescent phenomenon” has occurred. Lowering the dial 10 to 15 decibels from the point where the phenomenon was originally heard, then moving it quickly upward so as to go over the same spot, till it reaches the maximum intensity, there can be observed a perception, essentially evanescent, as

if it were a spark of the audition which emerged, dimming out at that limit

Another way of searching for the "vanishing perception" consists in maintaining the maximum intensity from the beginning, now it may happen that the patient hears the tone used in the test, and will suddenly fail to perceive it. If we go back looking for the same frequency at the maximum intensity a few seconds later, there is a possibility of its being distinguished in the fashion already described, that is, evanescently, while the audiometric tones of the neighborhood, and even those farther apart, are perceived differently. In order to obtain this effect easily, the following technic is advisable. We place the intensity dial at its maximum and, interrupting the sound, we abruptly change from one frequency that can be recorded, into that in which the "vanishing perception" has occurred, noticing then that it reappears as soon as the switch is on. It is advisable to go over the frequency range, and then go back to the point where the "fleeting manifestation" was heard, in order to get confirmation. With some skill and patience, it is possible by means of successive maneuvers to verify the intermittency of the sensation and also to determine how often it is observed during a test.

We might have made mistakes which would lead us to false conclusions. To avoid that, we have conducted our experiments carefully, being aware of any little thing. The first of them, the most elementary one, would be the misplacing of the bone conduction receiver. This was checked in every trial. A second cause of error, also due to the recorder, was to take a threshold at the maximum level of intensity as the "vanishing perception", careful analysis, followed by a good technic, showed us that the perception at the "extreme threshold" is more clear when one is using the tone switch which makes possible its recording, while the "vanishing perception" is not influenced by this. As was to be expected, some of our children would not give reliable responses to some of the tests. To avoid such a cause of error, their tests were excluded from further consideration in this study. Besides, not only with the children but also with deafened "grown-ups" having severe cochlear or nerve impairment we had the opportunity to test this same "evanescent perception". The answers of the latter may be regarded as absolutely correct, removing then all doubts, if any existed.

The last, but not the least, cause of error was to take a tactile sensation, though fugitive, as an acoustic one, for we accept the fact that auditory fatigue favors tactile interference. In a profoundly deafened person who is being tested by bone conduction, the vibration of a low tone fork may cause a tactile sensation, and this may be understood as an auditory one. Would it not be right to assume that the bone conduction receiver of the audiometer could act in the same manner?

Similar questions were asked by Hughson, Ciocco and Palmer<sup>7</sup> in their report of the results of studies by bone conduction in a group of children "Was it in every instance true perception by bone conduction, or at the high intensities of the lower frequencies was it purely tactile?" To these questions they answer "Experience with the particular bone conduction receiver used indicates definitely that at the maximum intensity of the frequencies 128, 256 and 512 cycles there is a definite tactile factor. However, the averages shown in the following tables are below this maximum intensity, and at the particular values for 512 cycles the tactile factor of the receiver is negligible. If, therefore, there is a response to the frequency, 512 cycles, it seems justified to assume that bone conduction is present." Those conclusions may be extended to the "vanishing perception," because it is an auditory sensation, though it lasts seconds.

Those authors admit that the tactile factor originates at the maximum intensity, and at the particular frequencies, say, 128, 256 and 512, at which the "vanishing perception" also appears. This might have created a serious objection to the observed facts if we had not noticed that during the experiments this perception was more frequent at 512 cycles, and at higher tones, while the former was more observed at the lower frequencies. To stress that, we may state that in 216 tests made by bone conduction, either in one or both ears, and at the different frequencies, the "vanishing perception" appeared fifty-two times at 1024 cycles, forty-six times at 512 cycles, forty times at 256 cycles, thirty-four times at 2048 cycles, twenty-three times at 128 cycles, eighteen times at 4096 and only three times at 8192 cycles. The great majority was heard at 1024 cycles and 512 cycles, frequencies with which the tactile factor was nihil or negligible. At 1024 cycles and at the higher frequencies the total percentage of the manifestations goes as high as 49.6, while at the lower frequencies it stays at 29.1, thus decreasing at the lower tones, with which the tactile factor is stronger. This is an element of the utmost importance when one seeks to define the perception of an acoustic sensation.

There is yet another circumstance which helps in differentiating the tactile factor from the "vanishing perception." In the test of the cranial perception, only the forks lower than the C (128 double vibrations) "gave a tactile sensation that could be interpreted as an auditory sensation" (Heiman<sup>8</sup>). As the lowest tone given by the Western Electric Audiometer corresponds to 128 double vibrations, a question comes to our mind. Does the tactile phenomenon occur at the maximum intensity with this frequency, as well as with 256 cycles? This may

<sup>7</sup> Hughson, Ciocco and Palmer,<sup>2</sup> p. 412

<sup>8</sup> Heiman, T. *L'oreille et ses maladies*. Paris, G. Steinheil, 1914, vol. 1, p. 365

be followed by another. May not this factor, described by the authors as tactile, be a manifestation of the bone, that is, a vibratory sensation due to the superficiality of the mastoid process, and thus interpreted as an auditory sensation?

The sensation, whether tactile or vibratory, which can be mixed up with the auditory one is of a steadier and longer duration, finishing simultaneously with the molecular vibrations of its source. Instead, the "vanishing perception," besides being an auditory sensation, is an intermittent phenomenon, of short duration, and can be verified at a certain moment of the sound vibration.

In order to find out whether the children were able to distinguish the auditory sensation by bone conduction from the tactile and vibratory ones, several experiments were made at the frequencies 128, 256 and 512, when tones could be perceived by bone and air conduction, or at least by the latter, at the higher intensities. Placing the bone conduction receiver, the intensity being kept constant, now on the palm or the finger tips, then against the child's mastoid process, and using the air receiver for comparison, we found that they were able to differentiate the sensations under test. Even if we admit that this factor is not exclusively tactile or superficial, because of the close proximity to the skeleton in this region (though much less close than the mastoid process)\* the important fact to us is that the children having some residual auditory perception were able to make a distinction between this strange factor and the auditory sensation. The results of those experiments have shown it to be possible for deaf children to distinguish an acoustic impression, though evanescent, from any other short sensation, and thus once more our point is stressed that the evanescent perception is an auditory phenomenon.

Urbantschitsch<sup>9</sup> and recently Douglas Macfarlan<sup>10</sup> have conducted researches in which they showed the possibility of differentiating tactile from auditory impressions in deaf children.

The younger pupils and the profoundly deaf ones went through a training period with the audiometer, in order to get used to the acoustic impressions, till they became able to distinguish these sensations from any others that could appear during the test.

Testing some children with such a severe hearing loss that it was almost impossible to record it, we had the opportunity of observing the same evanescent phenomenon by air conduction, though not so often, but

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9 Urbantschitsch, V. *Des exercices acoustiques dans la surdi-mutité et dans la surdité acquise*, translated by L. Egger, Paris, A. Maloine, 1897, pp. 79-81.

10 Macfarlan, D. *Distinguishing Between Tactile Sense and Audition in the Deaf Child*, *Arch. Otolaryng.* 5: 507-508 (June) 1927, *Tactile Sensation as Related to Hearing Testing and Hearing Impressions Through Nerves Other than the Eighth*, *Ann. Otol., Rhin. & Laryng.* 42: 680-689 (Sept.) 1933.

by all means similar to the one by bone conduction. This fact was plainly confirmed by the successive experiments. Like the vanishing perception by bone conduction, it always appeared at the higher levels of intensity and yet, because of its fugacity and intermittency, the recording of it was impossible.

In the cases in which the "vanishing perception" of an air-conducted frequency was observed, we found severe loss of hearing not only by bone but by air conduction, and the marks of the latter when recorded were scant and situated at the limit of the curve indicative of total loss of serviceable hearing. Chart 4 shows a good example of that, hearing by air conduction was recorded only at two frequencies around the curve aforementioned. Here the evanescent perception of

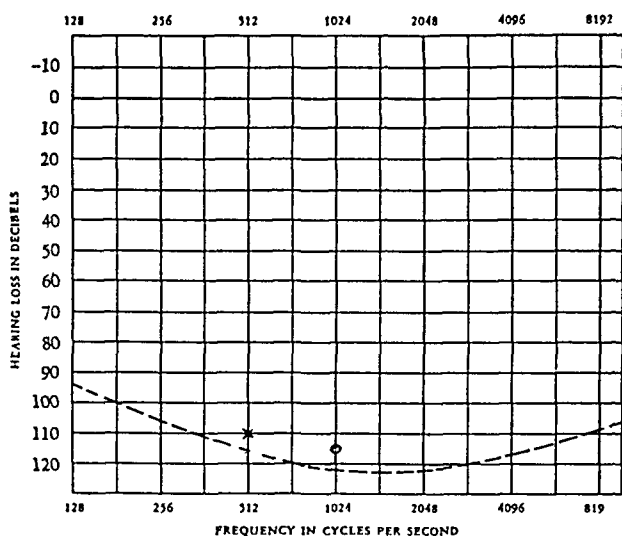


Chart 4—Audiogram of a case in which the vanishing perception was noticed by air conduction. The threshold of hearing recorded for the left ear is indicated by a cross, that for the right ear, by a circle.

air-conducted sound was observed at frequencies 256 and 512 in the right ear, besides the audiogram's marks (512 left ear and 1024 right ear).

We have observed the "vanishing perception" not only with children but also with adults having marked impairment of cochlear or nerve function—here less frequently. A typical case is one in which a 25 year old man suddenly lost hearing as a consequence of an acute disease of obscure cause with cerebral symptoms that produced a lesion of the auditory nerve. This patient, who had normal hearing before the infection, lost it almost completely, within six days, and when he was examined by us six months later, his failure to perceive the voice was total. He heard only the vibrations of forks C and C<sub>1</sub> when these were placed against his mastoid process, and even these vibrations not

so well, and for a short time. The patient had some subjective symptoms, such as dizziness, which usually appeared at night, but the vestibular tests gave negative results and the Romberg sign was not present. On making an audiometric test we noticed his extreme auditory loss, he was able to distinguish in the right ear, though in an intermittent and evanescent way, the frequencies 128, 256 and 512 by air conduction, he distinguished 256 in the left ear and 512 in the right ear by bone conduction.

"Vanishing perception" of air-conducted tone seems to show, in all the cases, that the degenerative process of the cochlea and the nerve accounting for this type of deafness has reached its final phase, thus "vanishing perception" appears at the same time as almost total loss of hearing, as shown in the audiograms.

#### INTERPRETATION AND STATISTICS

"Vanishing perception" may be looked on as an audiometric sign of a nerve lesion of the inner ear which is observed in persons with advanced deafness of the perceptive type, particularly in deaf-mutes. This phenomenon was more often recorded in tests of bone conduction.

According to Jones and Knudsen,<sup>11</sup> bone conduction furnishes a direct test of the cochlea, this is particularly true for frequencies above 2000 cycles. It is generally accepted that bone conduction is more related to the cochlea and the auditory nerve than is air conduction. Thus a decrease or a disappearance of hearing by bone conduction is a sign of impairment of the cochlea or of the auditory nerve, as we observed with children, and represents a serious disturbance of the perceptive apparatus.

The "evanescent perception"—accompanied by the impossibility of registering the audiometric tone—found mainly by tests of bone conduction, must be regarded as a symptom of greater damage of nerve elements of the ear and can be used in the diagnosis of this.

There are 200 audiograms of the total number of children tested with satisfactory results, and they show that this phenomenon was observed in 39 per cent of the children by bone conduction, in 4.5 per cent by air conduction and in 4 per cent by both air and bone conduction and that 52.5 per cent gave no responses of the evanescent type. It was noticed by air and bone conduction at one frequency at least and in one of the ears in 47.5 per cent of the audiograms, that is, in almost 50 per cent of the children under test, a fact giving clear evidence of the extreme importance of the phenomenon whether looked at from the scientific or from the statistical point of view. Of all of the cases

<sup>11</sup> Jones, I. H., and Knudsen, V. O. *Audiometry and the Prescribing of Hearing Aids*. Studies of the Eighth Nerve, St. Louis, The Laryngoscope Press, 1937, pp. 162 and 163.



in which this sensation was verified the perception was by bone conduction in 82.1 per cent, by air conduction in 9.5 per cent and by both air and bone conduction in 8.4 per cent

Table 4 and the curves of chart 5 show the distribution of cases in which perception was obtained evanescently in air and bone conduction tests throughout the frequency range. The data were obtained not only from the first audiometric tests but from the later ones, made in order to obtain this evanescent phenomenon over and over again

TABLE 4—*Frequencies and Cases in Which the Vanishing Perception Was Noticed in Bone and in Air Conduction Tests*

Frequency in Cycles per Second	Number of Cases			
	Air Conduction		Bone Conduction	
	No	%	No	%
128	6	13.06	29	8.77
256	7	16.28	67	20.25
512	7	16.28	83	25.08
1024	9	20.94	74	22.37
2048	5	11.62	49	14.81
4096	8	18.60	25	7.51
8192	1	2.32	4	1.21
Total	43	100.00	331	100.00

TABLE 5—*Frequencies and Cases in Which the Vanishing Perception Verified in the First Audiometric Experiments Was Noticed in Later Verifying Experiments*

Frequency in Cycles per Second	Number of Cases			
	First Proofs		Later Proofs	
	No	%	No	%
128	23	10.65	6	5.22
256	40	18.52	27	23.42
512	46	21.29	37	32.17
1024	52	24.08	22	19.13
2048	34	15.74	15	13.04
4096	18	8.33	7	6.09
8192	3	1.39	1	0.87
Total	216	100.00	115	100.00

The curve of cases in which the perception was obtained by bone conduction is smoother because of the greater number of observations taken

The statistics show that this phenomenon appeared by bone conduction three hundred and thirty-one times and by air conduction forty-three times at different frequencies, in one of the ears at a time, or in both, when this was the case

Of the three hundred and thirty-one times that it was observed by bone conduction, two hundred and sixteen were verified in the first tests, and one hundred and fifteen in the later ones, as shown by table

5 and chart 6 In the early experiments the vanishing phenomenon was noticed more frequently at 1024 cycles, at which scanty marks or thresholds, were recorded In the following tests it was observed much more at 256 and 512 cycles, occurring at the same time as the disappearance of the thresholds which were recorded in greater number in the early tests

The early experiments presented two different types of results the thresholds which were recorded (charts 1, 2 and 3) and those

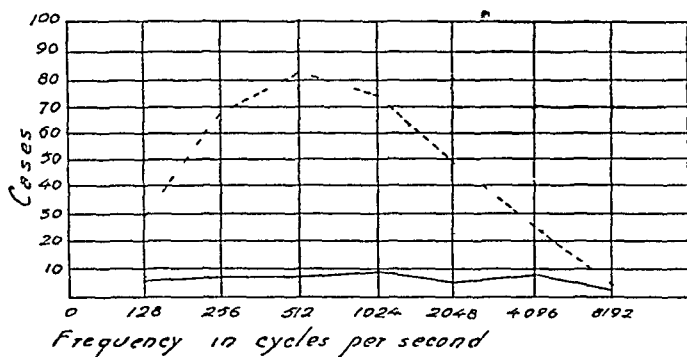


Chart 5—Comparative curves showing number of cases in which vanishing perception was noticed by bone and by air conduction Bone conduction is represented by a broken line, air conduction, by an unbroken line.

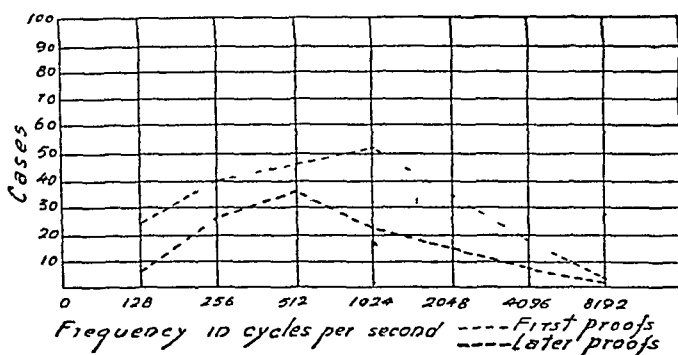


Chart 6—Comparative curves showing numbers of cases in which the vanishing perception was noticed by bone conduction, in the first and the later verifying experiments

which were observed evanescently—the first signs of the “vanishing perception” (chart 6)

The evanescent sensation appeared twenty-three times by air conduction in the first tests and twenty times in the later ones The phenomenon was observed, these twenty times, at the frequencies whose original marks had disappeared

To summarize, the “vanishing perception” appears much less at frequencies at which it was previously observed than at the new ones.

this being followed by the impossibility of obtaining the original marks. Among the one hundred and fifteen times that the evanescent perception of bone-conducted frequencies reappeared, sixty-one times it reappeared at different frequencies, only the remainder were as found in the original audiograms and at the original numbers of cycles.

It is not within the scope of this paper to analyze the mechanism of this phenomenon, but only to record its characteristics, later on, more accurate and well conducted research might bring out new facts which would confirm or modify those which we have already established, allowing them to be better interpreted.

The explanation of some new matters and the relation between the disappearance of the recordings when the "vanishing perception" was noticed led us to explain in a general fashion those successive manifestations that are related to the progress of the children's impairment. On account of that, we devote more attention to the subject. We shall describe briefly auditory fatigue and its relations, taking up afterward the study of the mechanism and of the "evanescent perception" and trying to explain it in a reasonable manner.

Auditory fatigue, as we know, can be observed either in normal or in pathologic conditions. The auditory fatigue observed under pathologic conditions was described by a few authors as due to an impairment of the auditory nerve. But this phenomenon under this circumstance was better studied by Urbantschitsch<sup>12</sup>. The characteristics of the acoustic *épuiement* (exhaustion) that he described have something in common with those of the "vanishing perception," more than any other factor connected with pathologic auditory fatigue. This author refers to auditory fluctuations and to tones which, normally heard by deaf persons, failed to be perceived seconds after, no matter how strong the intensity. He goes further, mentioning the case of a deaf-mute who after a few seconds fails to hear the tones of an accordion. Is there any relation between this phenomenon and the "evanescent perception"? Is it possible that the progress of science and the new technic have helped one to observe and measure better the same acoustic phenomenon, adding to it some new features?

It would have been possible for this remarkable man of science to observe a similar occurrence, though the instrumental condition was poor. But it is opportune to remember that he used in his experiments the spoken voice and the sound of the accordion, which can easily cause auditory fatigue. Conversely, the "vanishing perception" was obtained by bone and air conduction tests made with an accurate instrument—the audiometer—which produces pure tones with established frequencies.

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<sup>12</sup> Urbantschitsch,<sup>9</sup> pp. 75-79.

Recently experiments have been carried out by different authors in the study of physiologic fatigue. It has been thoroughly established that all normal ears fatigue when exposed to sounds of high intensity.

Under normal conditions auditory fatigue is a physiologic phenomenon, in the production of which cortical factors partake and play an important role<sup>13</sup>

We might therefore say that the "transitory perception" observed at high levels of intensity in cases of marked auditory loss is a sensorial or peripheral phenomenon closely related to the pathologic condition of the nerve elements of the ear, and found only in such cases. It would thus be regarded as a form of fatigue, essentially sensorial and connected with the degeneration of the nerve elements of the ear.

Since it is known that the auditory nerve and the cochlea when damaged easily fatigue, a reasonable explanation of the "vanishing perception" might be that of a greater tendency of the nerve endings of the organ of Corti or of the nerve fibers to become exhausted. This is due to severe anatomic changes which obstruct the nerve and cochlear function, making any response to auditory stimuli almost impossible. So, to the maximum degree of the lesion of the auditory nerve would correspond the maximum fatigue produced by audiometric tones when these are at high levels of intensity.

Now, a question comes up which is of utmost importance in the understanding of the evanescent phenomenon. Does the production of this phenomenon at a high level of intensity depend on the mechanism accounting for the fatigue or is the intensity alone able to produce this transitory sensation, regarded as the last vestige of auditory function before its final disappearance? Is it possible that this state of auditory loss favors fatigue? In this last hypothesis, the evanescent sensation would be attributed more to degeneration of the nerve elements of the ear than to auditory fatigue.

The "vanishing perception," so closely related to poor functioning of the cochlea and the auditory nerve, would mean in its essence the degeneration of auditory nerve elements. The point we want to stress is: Whatever the interpretation of its mechanism may be, the "fugitive perception" is a consequence of anatomic, physiologic and pathologic factors.

Contrary to the physiologic auditory fatigue, the transitory sensation when it appears at certain frequencies of the audiometric range does not affect hearing of any other frequency which was recorded. It is supposed to be connected with specific cochlear reaction verified at levels corresponding to that frequency at which the excitability is in a very weak stage. Its electiveness for some fatiguing tones seems to be

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13 Stevens and Davis,<sup>6</sup> p. 219

stronger than that observed by some investigators in cases of normal aural fatigue. Though this occurrence is more accentuated at the fatiguing frequencies, it may be extended over the surrounding frequencies and may even appear at those farther apart, with loss of the sensation.

The binaural nature of physiologic fatigue—which is an evidence of its connection with cortical factors—differentiates it from the evanescent phenomenon, which can be noticed in a single ear. This confirms our theory that the phenomenon is of sensorial or peripheral origin.

As we have shown, the “vanishing perception” by air conduction appears at the limit of the curve of “total loss of serviceable hearing.” At this point the excitability is extremely weak (severe deafness), although it is the threshold of feeling in normal hearing. Under such a circumstance there is slight possibility either of stimulation of the sensory cells or of conduction of a nerve stimulus, at that limit of hearing. Besides, in the case of bone conduction we have to regard the fact that the sound loses intensity before reaching the cochlea, owing to the very structure and elasticity of the cranial bones, and to some other factors, even under normal hearing conditions. It is obvious that such a loss is made worse when one is dealing with perceptive deafness. We have verified that by bone conduction there is a greater number of appearances of the evanescent phenomenon, this fact indicates that this phenomenon is related to a deficiency of loudness.

It is often noticed, during our tests, that certain frequencies, namely, 256, 512, 1024 or 2048, which were being perceived fugitively more often when bone-conducted, could be recorded when air-conducted at higher levels of intensity—this being the only possible way to register the tones which we had utilized. The vanishing phenomenon can be attributed to a lack of the intensity necessary to a nerve impulse which is to maintain a continuous sensation.

This is observed first by bone and then by air conduction at the “maximum limit of auditory loss,” and depends on the degree of development of the impairment. This accepted, the fugitive perception partakes of a series of progressive phenomena ending when the tones are no more perceived. It is a sign that the auditory loss is becoming worse, or rather it is the last stage of sensation of tones before the total disappearance of such sensation.

It is known that “the loudness produced by a tone exciting the ear must be directly related to number of fibers being excited and the rate at which the excitations occur, since each fibre always carries its maximum impulse” (Fletcher<sup>14</sup>). It may be accepted that in the

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14 Fletcher, H. *Speech and Hearing*, New York, D. Van Nostrand Company, 1936, pp. 126 and 127.

mechanism of the evanescent perception the temporary lack of intensity of nerve impulse is a result of poor excitability or conductability, having as its primary cause the anatomic lesions. It was only when this phenomenon was observed either with children or with adults whose nerve deafness was severe that we found these extreme conditions of loudness, excitability or conductability.

Summarizing, we may say that from an acoustic standpoint the vanishing perception is associated with a lack of sufficient intensity to support a steady sensation. From the physiologic and pathologic points of view it is related either to a very weak excitation of the hair cells of the organ of Corti or to a slight conduction of a nerve stimulus. From the anatomic point of view it is connected with the development of a degenerative process including both the nerve and the sensory organs.

# AUDIOMETRIC STUDIES OF THE RESIDUAL HEARING OF PUPILS OF RIO DE JANEIRO NATIONAL INSTITUTE FOR THE DEAF

## II Study of the Progress of the Impairment of the Children's Hearing

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IN OUR first study<sup>1</sup> we accepted the progressive nature of the pathologic condition of the deaf-mute child. We also defined "vanishing perception" and its characteristics, stating that it partakes of a series of phenomena ending with the total loss of perception of audiometric tones. Successive tests trying to register repetitions of this fugitive sensation in the same audiograms and at the same frequencies led us to the verification of these facts. This explains why statistical data were taken from first and later audiometric tests, the purpose being to make sure of the reproduction of the evanescent perception.

It was through consecutive trials that we came to observe in many cases some new facts which later on we shall relate to the pathologic process of deaf children. Those facts may be stated thus: There is a falling off or a disappearance of the thresholds recorded in first tests. The latter may or may not be preceded by the vanishing perception.

The evanescent sensation was verified much more often at new audiometric positions than at the ones where it was previously observed. It reappeared one hundred and fifteen times by bone conduction, and sixty-one of these times it was in different frequencies and later audiograms. The remainder of the times, that is, fifty-four times, it was found as on the original charts, at the same frequencies, and mostly with no significant changes being noticed in the thresholds. By air conduction it was observed twenty times in later tests. Eighteen of these times it was found in later audiograms, together with the impossibility of obtaining the original marks. Relatively speaking, the vanishing sensation is found more times in later audiograms for air conduction than it is in

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1 Lacerda, A. P., and Vervloet, A. E. Audiometric Studies of the Residual Hearing of Pupils of the Rio de Janeiro National Institute for the Deaf. I, Auditory Acuity of Deaf Children, Arch. Otolaryng. 45: 239, 1947.

later ones for bone conduction. This is understandable since it appears in the former at a phase of the process which is far more advanced and which is characterized in the audiogram by a few scattered threshold marks observed near the curve of "total loss of serviceable hearing."

Contrary to what was suggested by Hughson, Ciocco and Palmer<sup>2</sup> in their "Studies of Pupils of the Pennsylvania School for the Deaf"—that "the process of impairment was not progressive"—our observations left no doubt that the process was advancing, though in a sluggish fashion. This is stressed by the fact that the children's lesions are of a degenerative type and therefore progressive. They have based their theory on the fact that "when the subjects are arranged in age groups 6 to 9 years, 10 to 14 and 15 and over, no significant differences are apparent between the average thresholds of the three groups."

We thought that it would be advisable to compare our pupils' original threshold curves with curves obtained after a period of time had elapsed, in order to note any significant change. Bearing this in mind, we started a new series of experiments. The time intervening between the audiometric tests varied from one to five years, and all our attention was devoted to the slightest change of the threshold curves as determined by comparing these with the ones previously registered. The results recorded in most of the later audiograms indicate that

- (a) There was an increasing auditory loss, an evident sign of progressiveness
- (b) The characteristics of the loss could be determined from an analysis of the findings in air and bone conduction tests

Here, as in the previous work, we made sure that an accurate technic and the same instruments were utilized. The cases which we thought were more typical and the ones in which there were significant changes of auditory thresholds will now be described.

**CASE 1** (O. D., a 17 year old boy, etiologic diagnosis, congenital syphilis) — The first test was made on June 6, 1939, the second, on Dec. 3, 1943, the third, on Dec. 30, 1944.

*Air Conduction*—The audiograms obtained at the second test show no change. At the third test a difference of 15 decibels is noticed for the left ear at 1024 and 2048 cycles, and at the same time a threshold for 4096 cycles at 95 decibels has disappeared.

*Bone Conduction*—At the second test, frequencies 128, 256 and 512 are still perceived by both ears, but the right ear now perceives 512 cycles in an evanescent way. At the third test both ears fail to perceive frequency 512, and the left ear, 128 cycles, these frequencies are noticed only transitorily. The thresholds for 256 at 30 decibels are now at 45 decibels.

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<sup>2</sup> Hughson, W., Ciocco, A., and Palmer, C. Studies of Pupils of the Pennsylvania School for the Deaf. Auditory Acuity, Arch. Otolaryng. 29: 403-416 (March) 1939.



CASE 2 (A R, a 13 year old boy, etiologic diagnosis, congenital syphilis) — The first test was made on Aug 1, 1939, the second, on Dec 5, 1943, and the third, on Dec 6, 1944

*Air Conduction*—No significant changes are noted in thresholds of either ear in the audiograms obtained at the second and third tests

*Bone Conduction*—At the second test the curves, which had been exceptionally long at the first test, reveal that frequencies 128 and 1024 are no longer perceived in either ear, the same has happened to 2048 in the right ear and to 8192 in the

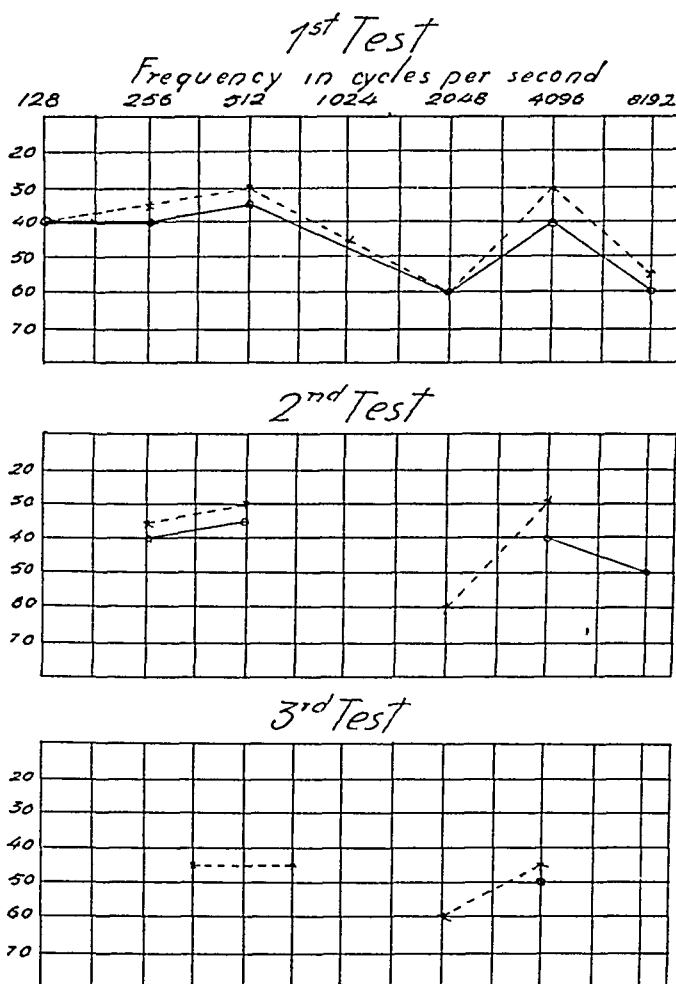


Chart 1—Case 2 Threshold curves for bone conduction only Left ear broken line, right ear, unbroken line

left ear No appreciable change is observed in the other thresholds At the third test we fail to record the thresholds of the right ear at 256, 512, 2048 and 8192 cycles In the thresholds of the left ear at 256 and 512 cycles a difference of 10 and 15 decibels is noticed, respectively, and at 4096 there is a dip of 15 decibels for each ear A vanishing perception was neatly observed in a tone gap at 2048 cycles in the right ear

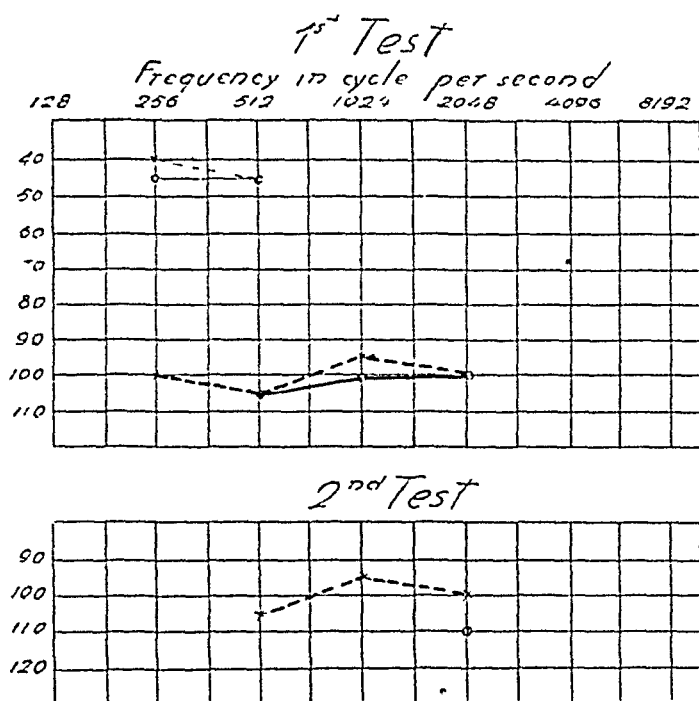


Chart 2—Case 3 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear unbroken line.

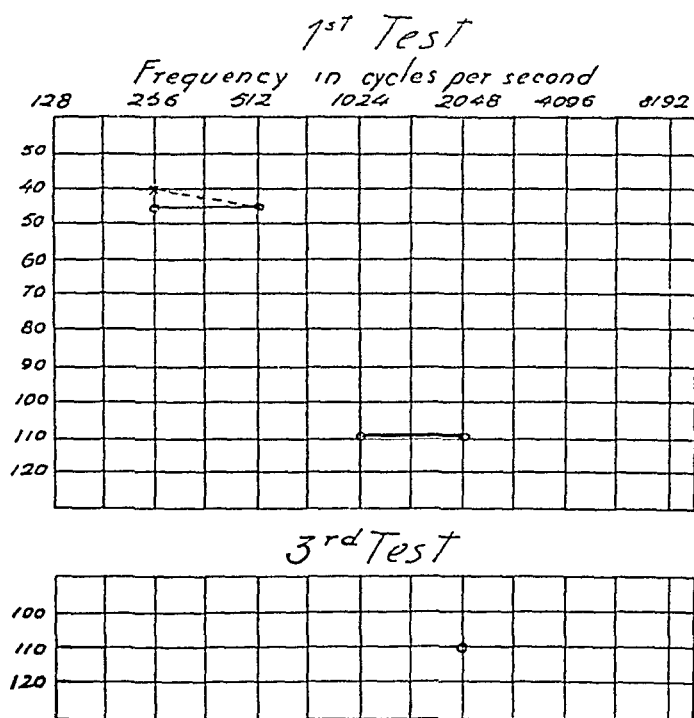


Chart 3—Case 4 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear, unbroken line

CASE 3 (L J D, a 17 year old girl, etiologic diagnosis obscure) —The first test was made on Dec 13, 1939, the second test, March 7, 1944

*Air Conduction*—In the second test the right ear fails to perceive 512 and 1024 cycles, and the left ear, 256 cycles. The threshold for 2048 in the right ear has fallen off 10 decibels and is now in the form of a "tonal island"

*Bone Conduction*—In the second test, instead of thresholds for 256 and 512 in both ears, vanishing perception is noticed, an exception being made of frequency 512 in the left ear. The intermittent phenomenon is no longer observed at 1024 cycles

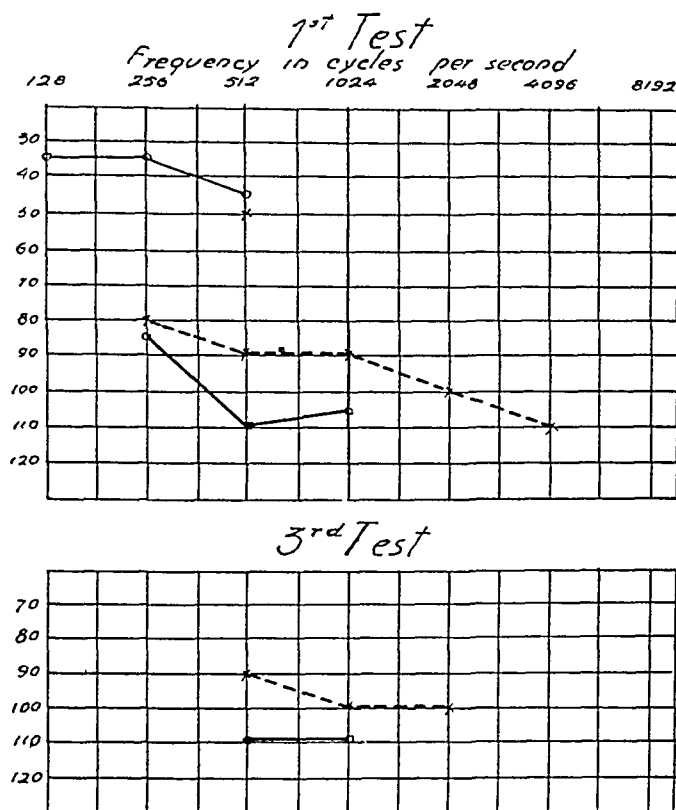


Chart 4—Case 5 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear, unbroken line.

CASE 4 (F A P, a 16 year old boy, meningitis) —The first test was made on Oct 27, 1940, the second, on Dec 3, 1943, the third on Dec 5, 1944

*Air Conduction*—In the second test there is observed a slight falling off (5 decibels) in the only two thresholds registered for the right ear, at 110 decibels. In the third test perception of frequency 1024 is becoming fugitive, the only threshold recorded is that for 2048 cycles (a "tonal island")

*Bone Conduction*—The thresholds for 256 and 512 cycles have disappeared in the second test.

CASE 5 (N O, a 14 year old boy, infantile paralysis) —The first test was made on Dec 22, 1940, the second, on Dec 4, 1943, the third, on Dec 30, 1944

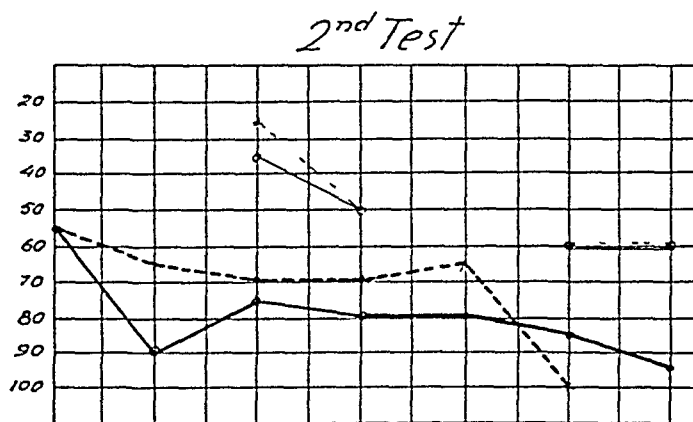
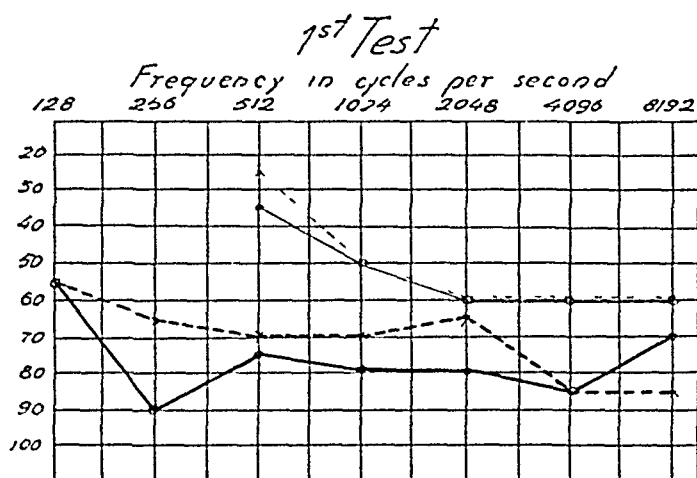


Chart 5—Case 6 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear, unbroken line.

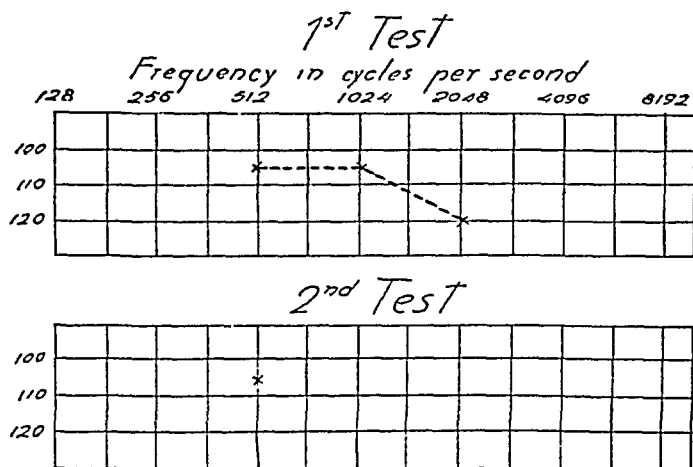


Chart 6—Case 7 Threshold curves for air conduction only Left ear, broken line, right ear, unbroken line (not shown)

*Air Conduction*—In the second test a slight loss (5 to 10 decibels) is noticed in the thresholds of the left ear. In the third test frequencies 4096 (heard at 110 decibels) and 256 (heard at 80 decibels) are perceived in the left ear in a transitory fashion, and the threshold for 256 at 85 decibels in the right ear.

*Bone Conduction*—At the second test it is no longer possible to obtain threshold for 256 and 512 cycles in the right ear and for 512 in the left ear. Frequency 128, heard so clearly in the first test, became fugitive in the second and was not perceived at all in the third.

CASE 6 (G F S, a 12 year old boy, hereditary alcoholism) —The first test was made on Oct 28, 1942, the second, on Dec 2, 1944.

*Air Conduction*—Changes are noticed in the long threshold curves of both ears at the second test. Frequency 8192 is now perceived evanescently in the

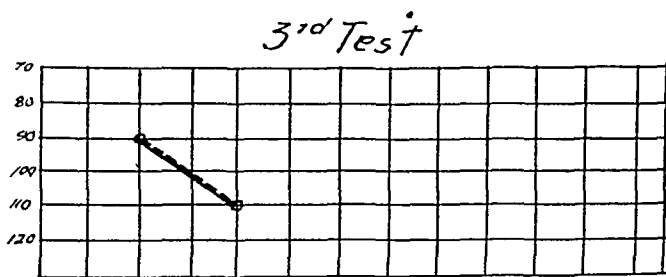
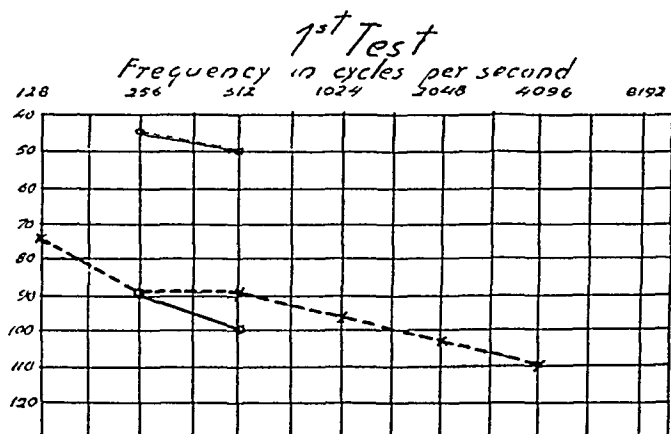


Chart 7—Case 9 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear, unbroken line.

left ear, a loss of 15 decibels is seen at 4096 cycles, and a greater one of 25 decibels at 8192 cycles, in the right ear.

*Bone Conduction*—In the threshold curves of both ears exceptionally long "tone gaps" appear at 2048 cycles, and at the same time a vanishing perception occurs in that frequency. The other thresholds do not change.

CASE 7 (I D M, a 16 year old boy, etiologic diagnosis, obscure) —The first test was made on Nov 4, 1942, the second, on Dec 6, 1944.

*Air Conduction*—Three thresholds are recorded at higher intensities of 512, 1024 and 2048 cycles in the first test. In the second test the first of them is still registered as a "tone island", the second is now a fugitive perception, and the third has entirely disappeared.

*Bone Conduction*—No thresholds could be recorded

CASE 8 (P B S, a 14 year old boy, congenital syphilis) —The first test was made on Nov 11, 1942, the second, on Dec 4, 1944

*Air Conduction*—In the long curves the threshold for 4096 cycles at 110 decibels is no longer present, having become fugitive in both ears. The same occurs with frequency 128 heard at 40 decibels in the right ear. The thresholds for 256 and 512 cycles of the left ear have fallen off 15 and 10 decibels, respectively.

*Bone Conduction*—In the left ear frequency 128 and in both ears 512 have completely disappeared. We still see a threshold for 256 at 45 decibels.

CASE 9 (P P, a 13 year old boy, congenital syphilis) —The first test was made on Dec 12, 1942, the second, on Nov 30, 1943, the third, on Dec 12, 1944

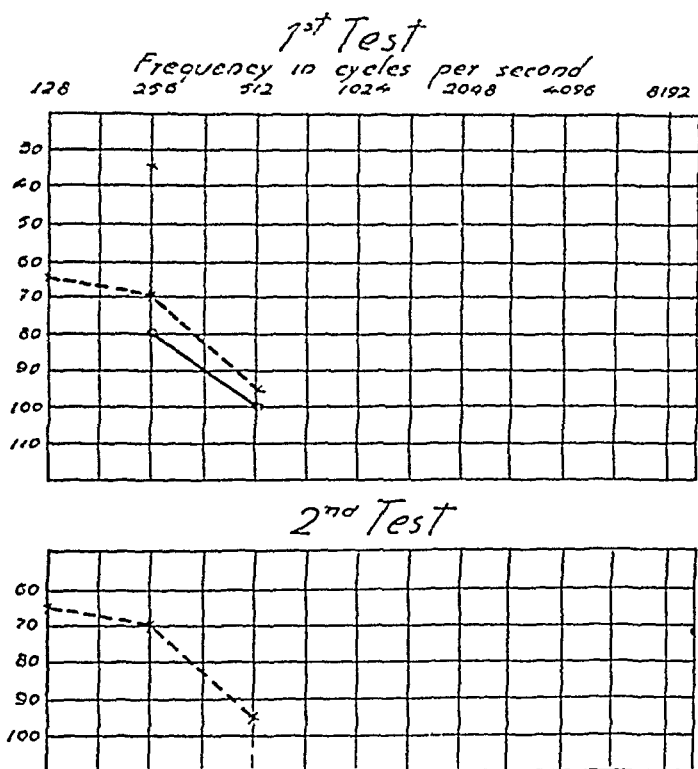


Chart 8—Case 11 Threshold curves for bone and air conduction (light and heavy, respectively) Left ear, broken line, right ear, unbroken line

At the second test the air and bone conduction thresholds remain unchanged. Frequencies 1024, 2048 and 4096, previously perceived in an evanescent way by bone conduction in the left ear, are still heard in a similar fashion.

*Air Conduction*—At the third test (left ear) the thresholds for 1024 cycles at 110 decibels, 2048 at 105 decibels and 4096 at 110 decibels become evanescent and that for 128 at 75 decibels is no longer perceived. In both left and right ears the threshold for 512 cycles has fallen off, respectively, 20 and 10 decibels, and is now situated at 110 decibels.

*Bone Conduction*—At the third test, neither frequency 256 nor frequency 512 was perceived, nor was vanishing perception noticed in either ear.

CASE 10 (J D R, an 18 year old boy, congenital syphilis)—The first test was made on Nov 25, 1942, the second, on Dec 8, 1943, the third, on Dec 5, 1944

*Air Conduction*—In later tests fugitive perceptions take the places of the thresholds for frequency 128 at 60 decibels and frequency 1024 at 110 decibels in the right ear, and the threshold for 128 at 65 decibels is no longer obtained, and that for 256 at 75 decibels has fallen off 20 decibels, in the left ear

*Bone Conduction*—Since the second test, evanescent perception is observed instead of the two thresholds recorded for the right ear (that for 256 at 40 decibels and that for 512 at 50 decibels)

CASE 11 (A S M, a 16 year old boy, congenital syphilis) —The first test was made on Nov 25, 1942, the second, on Nov 30, 1943, the third, on Jan 6, 1945

*Air Conduction*—At the second test, two thresholds of the right ear are missing (that for 256 at 80 decibels and that for 512 at 100 decibels), no changes are observed in the threshold curve of the left ear. At a third test, instead of three remaining thresholds of the left ear (that for 128 at 65 decibels, that for 256 at 70 decibels and that for 512 at 95 decibels) we observe a fugitive perception at the last two thresholds, while the first threshold has completely disappeared

*Bone Conduction*—At the second test the frequency 256 heard at 35 decibels in the left ear is now perceived evanescently. The vanishing perception of 512 and 4096 cycles noticed in the first test is still there. At the third test, sensation of any kind is no longer observed

Besides the aforementioned cases, a comparative study of losses by air and by bone conduction disclosed 32 others with results somewhat like those in the cases cited

We have examined 95 children. They were the ones whose audiograms were taken first and in whose cases the possibilities for further tests were verified. Appreciable changes were observed in audiograms of 43 boys, either in bone or in air conduction or in both. With the remaining 52 pupils changes were negligible or nil. Most of these pupils—the ones whose auditory acuity did not alter—went through acoustic training of various kinds in the auricular classes,<sup>3</sup> and others

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3 We may say that the acoustic training plays an important role in preserving the auditory curves of deaf children who have usable residual hearing. This is easily understood if one bears in mind the acoustic stimulation, mainly an intensive one, exerted by modern amplifiers of sound, which are now in use in the auricular classes

However, it was Goldstein's opinion that "After a residual-hearing child has been trained for four or five years in the acoustic method and another audiogram is made for otological check-up, it is found that the actual physiological hearing as indicated by the audiogram has not been increased. On the contrary, in some instances the audiogram shows further deterioration in the physiological hearing capacity. Our conclusion then must be that the ability of such a child to acquire speech through his ears is not an increased capacity for physiological hearing but is his mental education for the appreciation of spoken language." And Clarence O'Connor said "It is pretty generally accepted by all today, how-

were under active antisyphilitic treatment, this being suggested by the anamnesis and clinical signs. These factors have certainly contributed to the maintenance of the curves.

In cases 2 and 6 the curves for bone conduction are exceptionally long ones. The progressive impairment takes place in the form of "tone gaps" and "tone islands." These tone gaps, together with the other losses, show that the curves are taking an aspect more characteristic of the perceptive type of deafness, with a tendency for the bone conduction curve and the threshold marks of higher tones to disappear.

From the analysis of all the data obtained in these cases we may state that no apparent association was found between the advance of the impairment and the stated causes of the congenital or the acquired deafness.

No constant relation was observed between the amount of the loss and the time elapsed between tests. As an illustration we may point to the fact that audiograms taken at an interval of from three to five years and others taken at an interval of two and even one year have no significant difference among them. The losses were about the same in aspect and in intensity. This fact shows a difference in the rate of development of the process. Such a difference may be attributed to the amount of hearing first recorded, personal influence and some strange factors associated with the causation and the pathogenesis of the deafness, the relationship of which to auditory curves is not well established.

So far as the change of curves for bone and air conduction is concerned, the audiometric findings gave valuable information. In the majority of audiograms the bone conduction curves were not only the first but the more seriously damaged by the process. This explains why in so many cases an early and marked impairment is noticed in hearing for bone-conducted tones, which has constituted a characteristic feature of deaf children's thresholds. In all cases in which the air conduction curve was modified and thresholds for some frequencies were no longer registered, the bone conduction curve had gone through a much more accentuated change. A good example of this is seen in

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ever, that for the large majority of the pupils in schools for the deaf the major objective of acoustic training is the development of better speech and that in aiming for this one objective intensively, through the seeing-hearing method, all the other objectives will be reached to the fullest extent possible."

We cannot deny the importance of the pedagogic objectives. Not less important from an otologic standpoint is the improvement of the functional, or physiologic, activity of the ear, as stated by Urbantschitsch. Chances are better for children who have a greater amount of hearing and for the hard of hearing ones. In such cases it would be reasonable to think of a favorable influence of acoustic training on the audiometric curves.



the audiograms of case 4. In those when the thresholds for bone conduction can no longer be recorded, a threshold for air conduction is still present.

In audiograms characterized by long bone conduction curves, the high tones are the first to fail to be recorded. In the usual cases of shortened bone conduction, restricted to frequencies 256 and 512, a tendency was observed for the thresholds of these tones to disappear completely. This fact may explain why the bone conduction curve was not registered in many audiograms taken in the early tests, as well as the exclusion of higher tones that was observed in the deaf children's median threshold curve.<sup>1</sup>

The loss is first noticed in the bone conduction curve from the high toward the low tones, and it reaches the air perception curve in a more advanced stage of the process. A marked degree of impairment of bone conduction was also observed in the remaining 32 audiograms having pronounced changes in the curves, as in the 11 cases already described.

In cases 2 and 6 the places of thresholds for high frequencies were gradually being taken by gaps. In these gaps the vanishing perception occurred, this being the first sign of the total loss of the sensation, occurring just before perception has completely vanished.

The cases in which air conduction was similarly modified have the characteristics of those already described with regard to bone conduction. In case 3 the "tone island" at 2048 cycles is a result of the disappearance of thresholds of the right ear. In case 4 the "tone island" remained at 2048 cycles. Other "tone islands" are observed in cases 5, 7 and 9, this because high tones have disappeared.<sup>4</sup> In cases 5, 8 and 10 the progressiveness is more marked at the ending of the curves.

Nevertheless, we may say that both air and bone conduction have followed the same general pattern, that is, the loss of acuity is greater for the high tones of the frequency range. An early marked impairment of hearing by bone conduction is also observed. These facts are in agreement with the opinion of the majority of authors who have studied the perceptive type of hearing loss (Bonnafont, Moos, Lucae, Habermann, Bezold, Helmholtz, Baginski, Burckardt-Merian, Gradenigo, Alexander, Manasse, Crowe, Guild, Polvogt, Oda, Bunch and Ciocco).

Here again, the "vanishing perception" reappears in the majority of instances—cases in which progressiveness is present—more in other

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4 The displacement of "tone gaps" and "tone islands" observed in some audiograms of the first tests has become more characteristic during the progress of the impairment. This is the aspect taken by the auditory curves in cases in which the process is advancing in an uneven fashion in some tonal bands of the audiometric field. The "tone gaps" and the "tone islands" formed by the development of the deafness, together with the evanescent perception, may be regarded as signs associated with the progress of impairment.

frequencies and in later audiograms than in the ones in which it was previously observed. Of one hundred and fifteen times it showed up in the subsequent tests of bone conduction, seventy-seven were related to advancing processes. Sixty-one of these times it was found in new frequencies, mainly 256 and 512, where an absence of thresholds was verified, though in the early tests and at the very same frequencies these thresholds outnumbered any other ever recorded. In the remainder, that is, sixteen times it stayed in the same frequencies and audiograms. It is obvious that the evanescent phenomenon recurs much more at the same frequencies in cases in which the impairment is said to be stationary. While it recurred only sixteen times in 43 cases of a progressive impairment, it was noted thirty-eight times in 52 cases in which the changes were negligible or nil. Case 9 is a typical one. In the first stage, the one in which no changes occur, the evanescent perception reappears at the same positions. This is not observed in the second stage, characterized by a fast advancing impairment, which reaches the thresholds of perception of air-conducted tones.

The vanishing phenomenon was observed by air conduction in later tests twenty times, and nineteen of those times it replaced thresholds which were just vanishing, this being one of the signs, and sometimes the only one, of progressiveness in those audiograms (cases 4, 5, 6, 7, 8, 9, 10 and 11).

Every time the evanescent sensation failed to be perceived in frequencies in which it had previously been observed, the impossibility of recording it was also verified. This is a hint that a definite loss of sensation has taken place.

The evanescent appearance, when discerned by bone conduction at higher levels of intensity, as it often is, has the same characteristics as when observed at the maximum loss levels by air conduction. In cases 4 and 7 it was perceived at one of those scanty thresholds situated near the "curve of total loss of serviceable hearing." In case 8, with long threshold curves, the fugitive perception was observed by air conduction at two frequencies in which thresholds were recorded at high levels of intensity, proximal to the curve of maximum loss for these tones. The same was observed in cases 5, 9 and 10. So, it can be stated that the vanishing sensation at this upper limit of perception of air-conducted tones is the extreme condition of the sensation before the complete loss of hearing. It can be regarded as a transitory stage between the auditory threshold or, better, the audiogram mark and the complete disappearance of this mark. It is therefore a link in the chain of the progressive phenomena, that is, a threshold of hearing for a tone at a very high level of intensity, then a failure to record it, followed by the evanescent perception and finally the definite loss of sensation.

The bone conduction, the impairment of which is a first stage in the process, is more likely to have the vanishing sensation as well as a greater disappearance of thresholds, contrary to what is observed with air conduction, the impairment of which is the end of the road, where the chances for similar phenomena are fewer

The transitional stage of bone conduction—that is, the stage in which the evanescent sensation takes the place of an old threshold depends on a factor of an acoustic nature or, better, on lack of the intensity necessary if the nerve impulse is to keep up a steady sensation. The same is later on, in the final phase, observed with air conduction

It was noticed in many cases that a certain frequency was not perceived or was perceived in a fugitive way by bone conduction, then, if we tried it by air conduction, a threshold was recorded for the very same frequency, though at a higher level, which was the only possible way to register a threshold for the tone. This explains why a greater number of records was observed in air conduction curves and is an evidence of deaf children's auditory loss, this was also true in some cases of deafness of the perceptive type

It is obvious that there is needed an intensity high enough to allow a threshold to be recorded or to maintain a steady sensation when one is dealing with the evanescent phenomenon

This definite or temporary loss of the perception is first observed by bone conduction. Later on, depending on the degree of development of the impairment, it is observed by air conduction. The process so far as it has been analyzed may be divided into four main phases. In doing this we have taken as a starting point the most usual type of the deaf children's audiograms, corresponding to the median established in the first paper. The first phase is the one in which the thresholds, or marks, at high levels for bone conduction disappear (mainly those for frequencies 256 and 512), and this disappearance may or may not have been preceded by the vanishing perception. The thresholds for air conduction do not show any significant change. The second phase is characterized by the absence of records for bone conduction, only the air conduction thresholds are seen. These are somewhat widely placed, being spread over the frequency range at different high levels of intensity. The third phase shows the process more advanced. Only a few scattered marks are observed in the neighborhood of the threshold of sensation. Little by little they are being eliminated. This development takes place with or without evanescent perception, as was observed with bone conduction, though here the fugitive perceptions have a different meaning, for they signify the final stage before the complete disappearance of hearing. The fourth and last phase is constituted of the absence of marks and the "total loss of serviceable hearing." According to the data we have, those would

be the fundamental phases of the progressive impairment. Deviations from them may be found in our daily tests though they present the same basic features.

The progressive impairment is in most cases of a sluggish nature. Besides, it must be borne in mind that different factors may influence its progress by speeding it up or slowing it down. There is still the possibility that in one of these phases it may remain stationary. Among these elements an important one is the age of onset of the impairment—that is, whether the child has an acquired or a congenital type of deafness. Another, not less important, is the site of the lesion when this is attributed to different etiologic factors in childhood, as well as to constitutional damages and changes acquired during intrauterine life. In other words, the etiologic and pathogenic mechanism and the biologic constitution of deaf children are important elements in the development of the auditory pathologic process.

These different angles of the problem are, by themselves, enough to warrant further research and a more accurate study of this subject. Our first results were restricted to the comparative study of the auditory loss and its characteristics by air and bone conduction tests in the diagnosis of this type of deafness. However, they have suggested new experiments which might be undertaken in the measurement of auditory acuity and further clinical studies which might bring a new source of light into the pedagogy and the therapeutics of deaf children.

In our coming experiments in this obscure field we shall take up the subject in its scientific details, not overlooking the clinical aspect, which seems rather important to us. Then we shall be able to make a far more accurate study of the facts heretofore observed and to investigate the new ones. We shall try to settle more definitely the matter of the association of the rate of progress with the age of onset of the impairment and the etiologic and pathogenic factors responsible for the auditory lesions in deaf children. We shall also consider a matter which has been the subject of delayed attention, the great help that acoustic training and specific treatment may bring in cases in which the process has become stationary.

Some features that we and other authors have observed in connection with the good results obtained from the auricular method, that is, the better use of deaf children's residual hearing, entitle us to accept the possibility of the maintenance of audiometric curves. This was especially observed with children who underwent acoustic training and those who received auditory stimuli from various sources. Furthermore, in dealing with such patients there is the possibility that one may obtain improvement of the physiologic capacity of the ear. This is done through pedagogic training and adequate therapeutics, provided rational means are used. Some careful thinking should be devoted to these mat-

ters by those who intend to carry on such experiments, since the results accomplished in this particular field seem to warrant further investigations, however difficult the approach may be

#### SUMMARIES AND CONCLUSIONS

The hearing of 241 boys and girls of the National Institute for the Deaf, Rio de Janeiro, Brazil, was examined with respect to both air and bone conduction. The ages ranged from 7 to 21 years. The audiograms of 200 children who gave satisfactory responses served as the basis for a statistical analysis which was undertaken for scientific purposes.

We have obtained 379 threshold curves by air conduction and 233 by bone conduction. Charts made from the statistical data show air conduction curves longer than bone conduction curves. Noticeable is a greater loss of hearing for high tones by both air and bone conduction.

The charts show that in the majority of these children the loss of hearing is bilateral and approximately equal in the two ears by both air and bone conduction.

It was verified that 97.5 per cent of the children responded to at least one tonal frequency in one ear when tested by air conduction. Only in 2.5 per cent of the audiograms was no response to auditory stimulation registered in either air or bone conduction trials.

Seventy per cent of the children examined were said to have been born deaf. The percentage of those who presumably acquired the deafness after birth is about 30 per cent. The differences among the children's audiograms of both groups are not regarded as significant.

No significant difference in the threshold curves of the two sexes is to be noted. There is no apparent association between etiologic factors and the audiometric curves.

The audiometric curves give a picture of the functional disturbance of the perceptive type of deafness. This is commonly observed in connection with pathologic mechanisms resulting from damage of the auditory nerve or of the hair cells of the organ of Corti, or from a process involving them.

A slight and transitory perception which we found unrecordable was noticed mainly in tests of bone conduction. Due to its peculiar behavior we named this very especial auditory phenomenon "vanishing perception" of audiometric tones.

The vanishing perception, from an acoustic standpoint, is associated with a lack of the intensity needed to keep up a steady sensation. From the physiologic and pathologic point of view it is related to a slight excitation of sensory cells or to a slight conduction of a nerve stimulus. From the anatomic point of view it is connected with the development of a degenerative process including both the nerve and

the sensory organs. It may be looked on as a sign of an inner ear nerve lesion which is observed in an advanced stage of deafness of the perceptive type, particularly in deaf-mutism.

The evanescent sensation is the last stage prior to the complete loss of sensation of the audiometric tone either by bone or by air conduction. In the instance of air conduction it is regarded as the extreme condition of the perception of the tone before the total disappearance of perception of this tone.

The fugitive perception partakes of a series of progressive phenomena ending with total loss of hearing. It is a transitory stage between the audiogram mark of a threshold and the complete disappearance of this mark.

Ninety-five children underwent subsequent audiometric tests. The time between tests ranged from one to five years. When the later audiograms were compared with the early ones, significant changes were noticed in 43 cases. They may be outlined: falling off of the marks, or thresholds, and disappearance of some of those previously recorded, sometimes preceded by the fugitive perception. That is an evidence of progress of the impairment. In the remaining 52 cases no change was observed. In these cases the pupils attended the auricular classes or were under active specific treatment.

On the basis of the analysis of all the findings in these cases we may state that no apparent association was found between the progress of the impairment and the stated causes of the congenital or the acquired deafness. No constant relation was established between the amount of the loss and the time elapsed between tests.

The general features of the advancing process are: an early marked impairment of perception of bone-conducted frequencies and a tendency toward a greater loss of perception of high frequencies whether conducted by air or by bone.

The process may be divided into four main phases according to the degree of the loss of hearing. Different factors, not well established, influence these successive phases by speeding up the process, slowing it down or holding it stationary.

These different aspects of the problem are, by themselves, enough to warrant further research and a more accurate study of the subject, with the results being applied to the pedagogy and the therapeutics of deaf children.

## BONE-DUST-FREE LEMPert FENESTRA NOV-OVALIS

A New Evolutionary Development of the Surgical Treatment of Clinical Otosclerosis

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**I**N A DISCUSSION of osteogenesis following the fenestration operation in the human ear, in the May 1940 issue of the ARCHIVES OF OTOLARYNGOLOGY,<sup>1</sup> I stated

From my observations during revisions of the fenestra, I was forced to conclude that new bone regeneration within the fenestra begins not in the periosteal but in the endosteal layer of the bony capsule and either may stop there, without involving the periosteal layer, or may eventually involve the periosteal layer of the bony walls of the fenestra,

In the November 1947 issue of the ARCHIVES OF OTOLARYNGOLOGY Lindsay,<sup>2</sup> in an analysis of his histologic observations of the results following fenestration of the labyrinth of the rhesus monkey, corroborated the observations which I had made in the human subject and stated

Failure to maintain an open fistula was in most cases due to the osteogenetic process which took origin from the endosteal surface at the margins

In the surgical treatment of clinical otosclerosis, bone sand and bone splinters have always been the by-products of fenestrating the bony labyrinthine capsule with the electrically driven burr. When the final endosteal bony layer is fractured inward and pulverized, bone dust and bone splinters are pushed in the direction of the perilymphatic space, with most of them coming to rest on the shredded endosteal membrane and the endolymphatic labyrinth. It has been a well recognized fact that when these bone particles are not meticulously removed from the region of the fenestra they may stimulate and enhance the naturally existing tendency for osteogenesis to occur in the freshly cut bony walls of the fenestral rim.

It is for this reason that various methods of removing the fractured and pulverized endosteal layer of the bony capsule, which is seen resting on the shredded endosteal membrane and the endolymphatic labyrinth, are being practiced by otologists doing fenestration surgery.

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Read at the Atlanta Postgraduate Medical Assembly, Atlanta, Ga., Jan 28, 1948

Work aided by a grant from the Lempert Research Foundation, Inc

1 Lempert, J. Endaural Fenestration of External Semicircular Canal for Restoration of Hearing in Cases of Otosclerosis. Summary Report of One Hundred and Twenty Cases, Arch Otolaryng 31 711-779 (May) 1940

2 Lindsay, J. R. Healing of Experimental Labyrinthine Fistulas. Further Observations, Arch Otolaryng 46 584-600 (Nov) 1947

However, every careful otologist practicing fenestration surgery could not help but observe that in fracturing and pulverizing the endosteal bony layer of the fenestral region, bone dust and bone splinters unavoidably fall into the perilymphatic space and frequently disappear beyond visualization and retrieval

Lindsay, after having made similar observations following experimental fenestration in the rhesus monkey, stated in the November 1947 issue of the ARCHIVES OF OTOLARYNGOLOGY<sup>2</sup> that

The histologic examination has demonstrated that although at operation the technic appeared to be carried out faultlessly the complete removal of bone dust and fragments was rarely accomplished

Attempts at removing bone splinters from the perilymphatic space often result in severance of some of the perilymphatic trabeculae and trabecular blood vessels, as a result of which blood escapes into the perilymphatic space

The endolymphatic labyrinth can easily be injured by a bone splinter left within the perilymphatic space or torn in attempts to remove such a splinter from the perilymphatic space (fig 3A)

As a result of making careful observations in the performance of 414 revisions of fenestrated human ears, as well as in histologic studies of the temporal bones of our experimentally fenestrated rhesus monkeys,<sup>3</sup> I am convinced that bone dust and bone splinters entering the perilymphatic space are a much more serious threat to the hope of obtaining and continuously maintaining practical serviceable hearing as a result of fenestration surgery than bone dust and bone splinters resting in the region of the fenestral rim. This is so because bony fragments lost in the perilymphatic space are often not removable, while bone particles in the region of the fenestral rim can, as a rule, be completely removed

#### TWO CLINICAL PICTURES SUGGESTING POSTOPERATIVE OSTEOGENESIS

In my postoperative clinical study of the 3,400 patients on whom I performed fenestration operations, I was able to observe two distinct clinical pictures each of which could be indicative of an osteogenetic process that had taken place postoperatively

*Clinical Picture 1*—A patient who had practical hearing restored and who maintained this improvement at that high level for six months to a year suddenly begins to lose his hearing gain, and slowly his hearing acuity returns to the preoperative level and remains more or less at this level for some time

<sup>3</sup> Lempert, J, Meltzer, P E, Schall, L, and Wolff, D. Osteogenesis Following Fenestration of the Vestibular Labyrinth of the Rhesus Monkey. A Controlled Experimental Study, Arch Otolaryng 46 512-527 (Oct) 1947





Fig 1—*A* and *B*, perilymphatic trabeculae and trabecular blood vessels normally present within the perilymphatic space of the external semicircular canal of an 8 month fetus

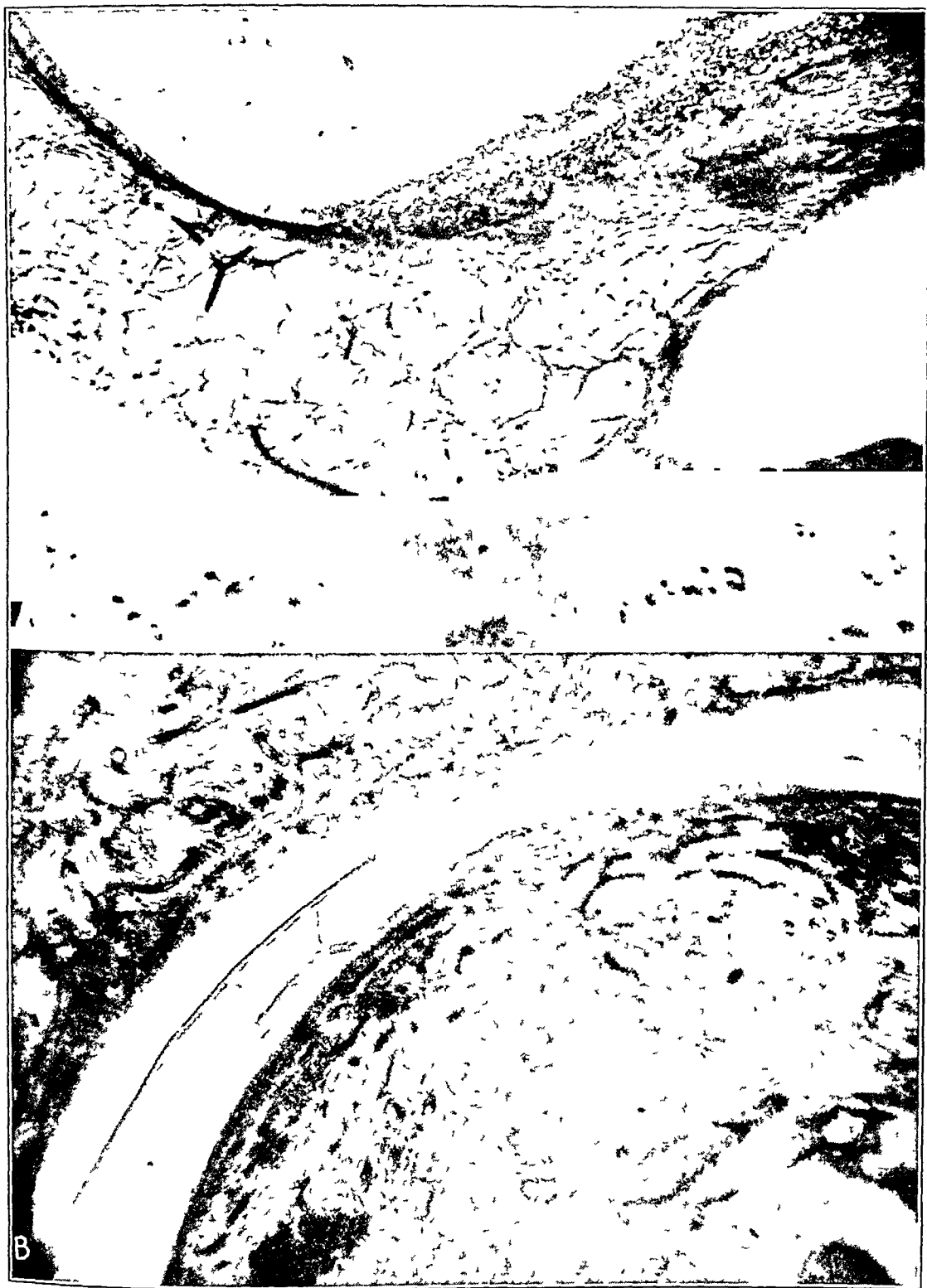


Fig 2—*A*, perilymphatic trabeculae and trabecular blood vessels normally present within the vestibular perilymphatic space of a 3 day old infant *B*, trabecular blood vessels within the perilymphatic space of the crus commune of the right ear of monkey 21, W L



Fig 3—*A*, right ear of monkey 24, experiment II. Bone splinters which had been unavoidably lost within the perilymphatic space injured and distorted the endolymphatic labyrinth. Bone regeneration is complete at the rim of the fenestra. The fenestra is closed. *B*, right ear of monkey 28, experiment II. This shows the ideal postoperative state of the perilymphatic space of a fenestrated external semicircular canal. There are no bone fragments in the perilymphatic space. The endolymphatic labyrinth, the perilymphatic trabeculae and the trabecular blood vessels have remained undisturbed and uninjured. Osteogenesis has taken place only at the fenestral rim.



Fig 4—*A*, left ear of monkey 42, experiment III. Perilymphatic endosteal osteogenesis was incited by bone particles unavoidably lost within the perilymphatic space. No bone regeneration has taken place at the fenestral rim, and the fenestra remains patent. *B*, right ear of monkey 46. The perilymphatic space is almost completely occluded by endosteal osteogenesis, which was initiated by bone particles unavoidably lost in the perilymphatic space. Osteogenetic closure of the fenestra can be seen.

In the vast majority of patients presenting this postoperative clinical picture, inspection of the fenestral region during revisions revealed that bone regeneration was limited to the fenestral rim of the bony labyrinthine capsule. When the newly formed endosteal bony growth was removed from the fenestral rim the hearing as a rule immediately improved, and when osteogenesis did not recur, this improvement continued indefinitely. If osteogenetic closure of the fenestra took place once again, the hearing again receded to the preoperative level.

In a few patients belonging to this clinical group I found no bone regeneration of fenestral rim but observed some narrowing of perilymphatic lumen as a result of endosteal osteogenesis. In these



Fig 5—Right ear of monkey 29, experiment II. The perilymphatic space is completely occluded and obliterated by endosteal osteogenesis, which was instigated by bone particles irretrievably lost in the perilymphatic space. Bone regeneration at the rim of the fenestra is complete, and the fenestra is closed.

the hearing showed no improvement following revision, and not infrequently the hearing continued to recede still further after the revision.

*Clinical Picture 2*—A patient who had practical hearing restored after the fenestration operation begins to lose his hearing improvement at the end of six months or so, and his hearing more or less rapidly reaches the preoperative level, but instead of remaining at that level for some time it continues to deteriorate to a level lower than that.

The abnormalities grossly observed with the aid of magnification on revision of the fenestra in such cases were usually of a more serious

nature Here the osteogenetic process was observed to have involved extensively both the fenestral rim and the perilymphatic space The hearing in these cases did not improve following revision and continued its downward trend

In analyzing these findings in the two groups of patients it became obvious that, since I have always meticulously removed the bone fragments visualized in the region of the fenestral gap, the osteogenetic process observed in the bony fenestral rim was started by the inherently existing tendency for repair to take place within the freshly injured bony layers of the fenestral rim (fig 3B)

However, the endosteal osteogenetic processes observed within the perilymphatic space during revisions of fenestrated human ears could not be explained on this basis, since injury to the endosteum-lined perilymphatic space is normally not part of my surgical technic I therefore reasoned hypothetically that perhaps the perilymphatic endosteal osteogenetic processes which I observed in the human subject had been initiated by bone fragments that found their way unnoticed into the perilymphatic space

Histologic studies of our experimentally fenestrated rhesus monkeys have confirmed my suspicions that irremovable bone fragments entering unavoidably and unnoticed and remaining in the perilymphatic space do create endosteal osteogenesis in the perilymphatic space, a non-remediable condition which when occurring subsequent to the fenestration operation in a patient is most damaging to the expected end results (figs 4 and 5)

In view of the clinical and operating table observations made in the human subject after fenestration of the labyrinth for clinical otosclerosis and the histologic observations made in the fenestrated labyrinths of rhesus monkeys, it became obvious that just as long as the creation of the fenestra nov-ovalis involves fracturing inward and pulverization of the endosteal bony layer of the labyrinthine capsule some of the bone splinters and bone dust thus formed will frequently fall into the perilymphatic space and unavoidably disappear beyond retrieval within it

In order to avoid the dire consequences and untoward end results observed, which were caused apparently by nonretrievable, unavoidably lost bone fragments within the labyrinthine perilymphatic space, I have gradually developed a new technic which I now exclusively employ for fenestrating the surgical dome of the vestibule without creating bone splinters and bone dust

#### TECHNIC

*STEP 1 Creation of an Endosteal Bone Cupola on the Surgical Dome of the Vestibule*—With an electrically driven 1 mm dental polishing burr, the bony capsule of the surgical dome of the vestibule is gradually worn down to the endosteal bony layer, until it is thinned to a bluish gray transparency The bony capsule

is then slowly and gradually worn down both anterolateral and posterolateral to the bluish gray transparent area until a bluish gray cupola of endosteal bone is created on the surgical dome of the vestibule. The bone dust formed is constantly removed by irrigating with saline solution and suction.

**STEP 2** *Circumferential Incision of the Base of the Bony Endosteal Cupola*—In an absolutely blood-free surgical field free from bone debris, the base of the cupola is incised as follows. The anterolateral aspect of the base of the cupola is pierced with a small sharp perforating knife in the direction of the perilymphatic space. A linear incision is then carried from the perilymphatic space outward through the endosteum and endosteal bone along the entire circumference of the base of the cupola.

**STEP 3** *Eversion and Removal of the Intact Bony Cupola to Uncap the Perilymphatic Space and Expose to View the Endolymphatic Labyrinth*—With a flat spatula-tipped excavator, the anterolateral margin of the base of the endosteal bony cupola is engaged, gently lifted and everted in a direction posterolateral to the fenestra and removed intact. The endolymphatic labyrinth, without having been disturbed from its normal position, is thus exposed to view.

**STEP 4** *Lead-Burnishing of the Bony Fenestral Rim to Prevent Osteogenesis Within the Bone-Dust-Free, Freshly Cut Bony Rim of the Fenestra*—With a pure lead burnishing burr held in an especially devised steel pencil holder, the bony rim of the fenestra is hand burnished.

#### ADVANTAGES

1 When this new technic is employed for creating the fenestra nov-ovalis, the endosteal bony layer of the labyrinthine capsule is neither fractured inward nor pulverized. Since no bone particles are formed, none can be lost in the perilymphatic space. Therefore, neither the endolymphatic labyrinth nor the trabecular blood vessels are ever in danger of being injured by bone splinters.

2 Since there are no bone particles to be lost in the perilymphatic space, endosteal osteogenetic processes formerly stimulated in the perilymphatic space by such bone particles are no longer possible.

3 With this technic, the endolymphatic labyrinth always maintains its normal position within the perilymphatic space.

4 Fenestration surgery can thus be performed without traumatizing the endolymphatic labyrinth, the trabeculae or the endosteal perilymphatic membrane.

#### SUMMARY

To further enhance the possibility of permanently maintaining the practical serviceable hearing following the Lempert fenestra nov-ovalis operation, (1) a new method of creating a fenestra in the vestibule of the labyrinth without producing bone dust and bone splinters is described, (2) the clinical and histologic factors influencing the necessity for its development are given and (3) the advantages expected to accrue as a result of this new evolutionary development are stated.



Fig 6—The three histologic layers of the bony capsule of the external semicircular canal, namely, the periosteal, enchondral and endosteal layers, are seen. The endosteal membrane lining the perilymphatic space of the external semicircular canal and vestibule is also seen. Within the perilymphatic space the endolymphatic labyrinth, consisting of external semicircular canal, utricle and saccule, are apparent. The crista of the external semicircular canal is seen crossing the ampulla.





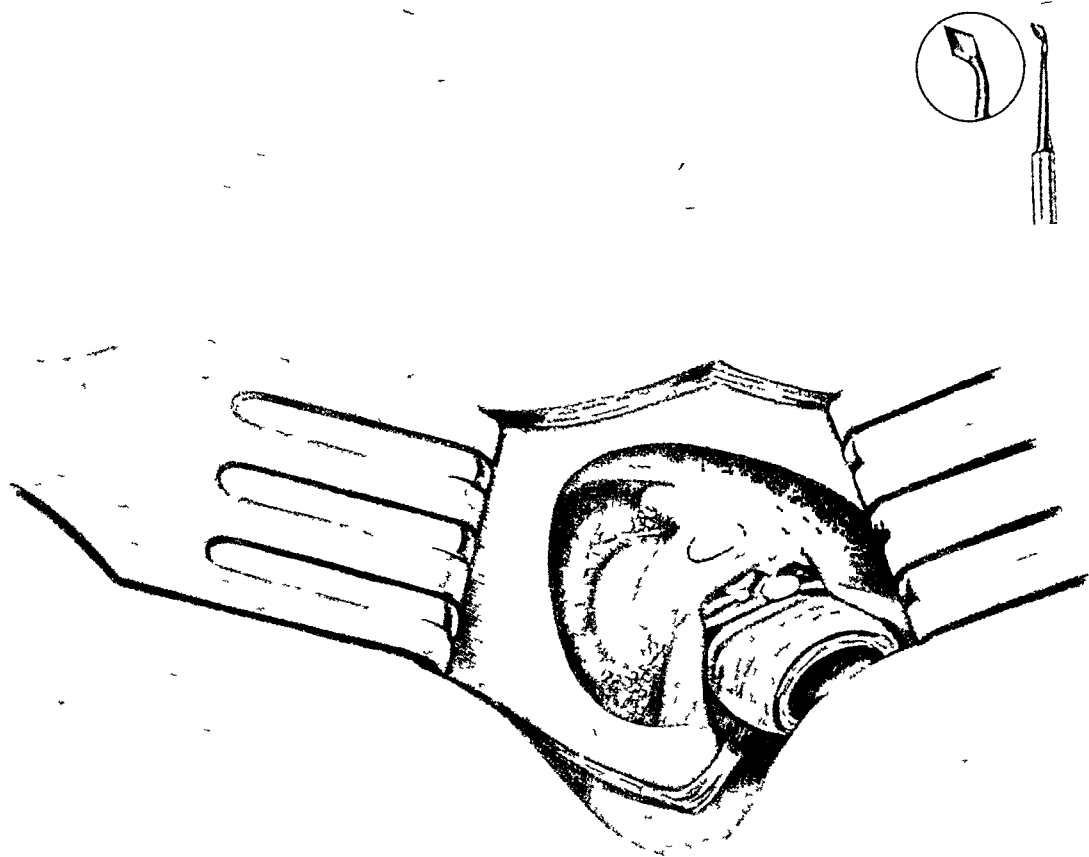


Fig 8—Step 2 The base of the bony endosteal cupola is incised circumferentially



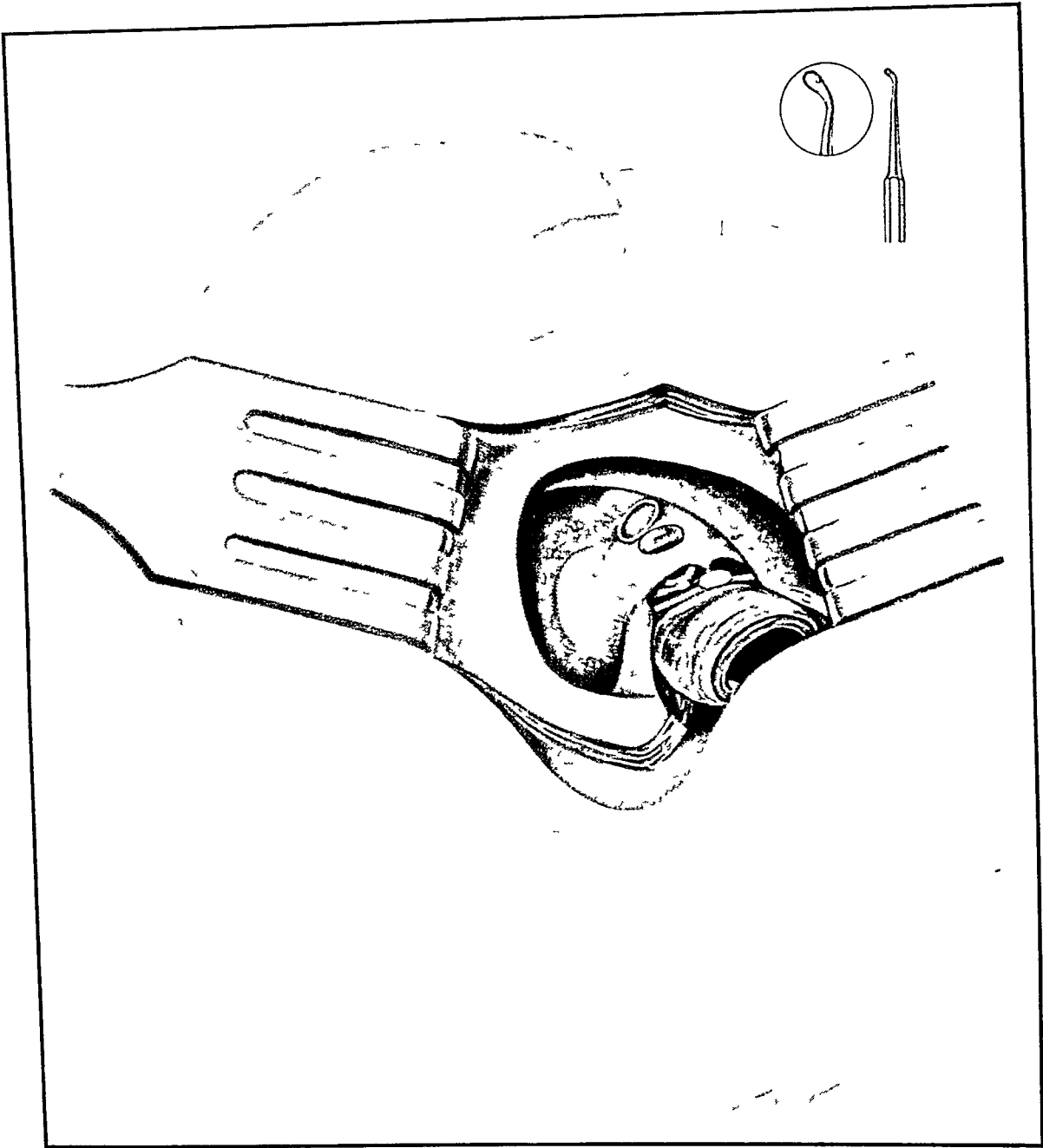


Fig 9—Step 3 The bony cupola is everted and removed intact to uncap the perilymphatic space and expose to view the endolymphatic labyrinth



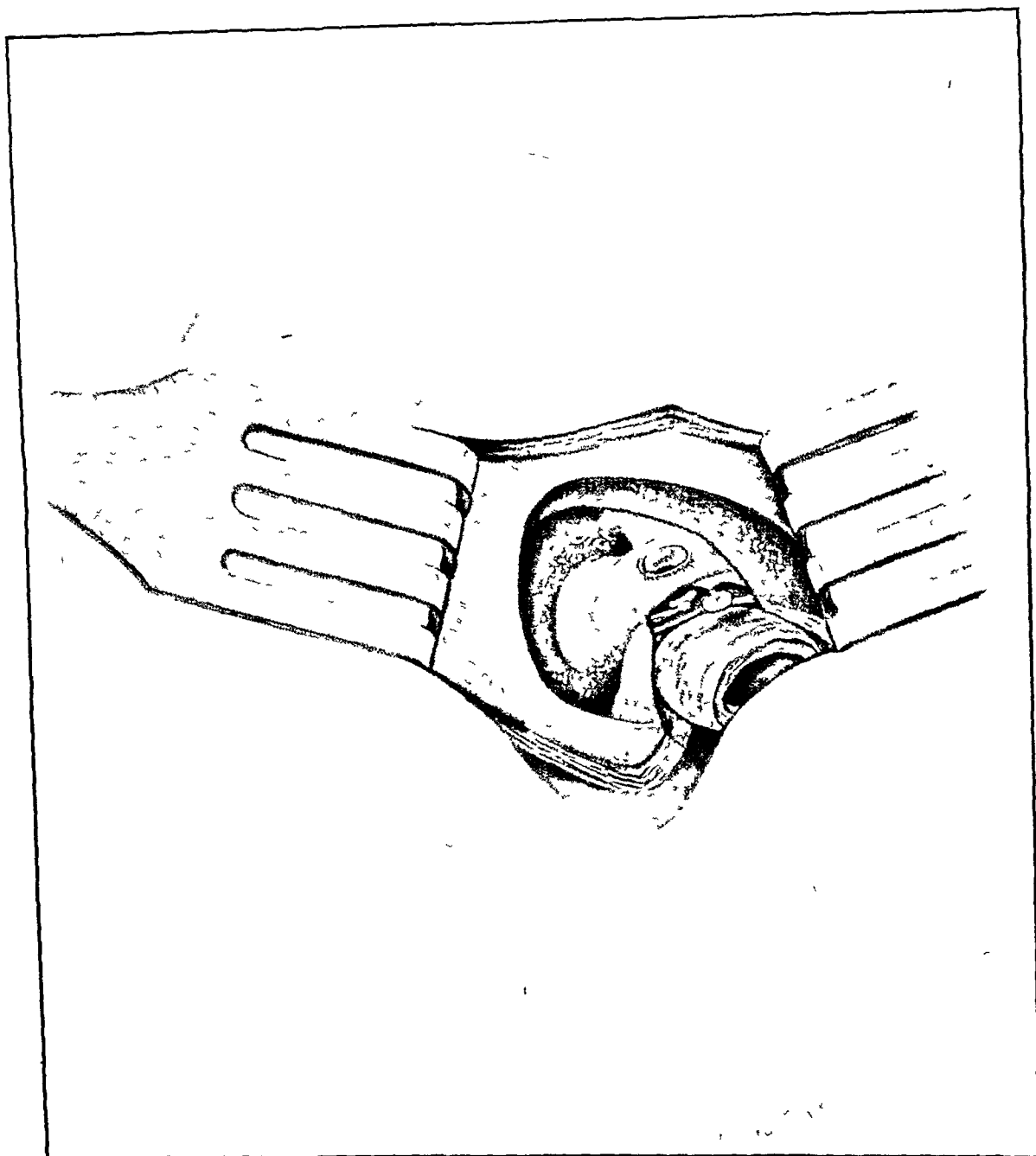


Fig 10—Step 4 The bony rim of the fenestra is burnished with lead



## A NEWER CONCEPT OF THE MANAGEMENT OF OTOGENIC INFECTION

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**I**N THE temperate zones otologic practice can be divided generally into two distinct seasonal phases. One is the summer phase, during which conditions are essentially the same both indoors and out as regards temperature and humidity. During the second, or winter, phase people live in different environments, the dry, warm indoors and the variable, cold outdoors. During this phase the human economy is subject to great fluctuations of temperature and humidity over relatively short periods. As a result, people have fall, winter and spring colds, with the ensuing complications, not the least of which are otogenic infections, such as otitis media and mastoiditis.

During the summer phase otologists see relatively few infections of this type but a greatly increased number of external otogenic infections. In addition, they frequently encounter exacerbations of chronic otogenic infections, which have been artificially activated by swimming, excessive sweating and bathing, with consequent pathologic aural changes.

If otogenic infections are studied bacteriologically, it will be found that the winter varieties are due predominately to gram-positive organisms. On the other hand, it has been noted by many observers that the primary infective agents in the external or summer type of otogenic infection are not the fungi or the gram-positive organisms but *Pseudomonas aeruginosa* (*Bacillus pyocyaneus*) or the *Proteus* group. Often in external otitis the infection is mixed, with both gram-negative and gram-positive organisms present. With the recent advance in chemotherapy and the use of antibiotics, otologists can show time and again how they can eliminate the gram-positive organisms and yet have the gram-negative ones flourish, their virulence unabated.

During the past five years we have observed a great many patients with otogenic diseases of all types. In their treatment we have been

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able to eliminate in a large measure the gram-positive organisms that cause morbidity. In six infections of the mastoid process treated surgically during the past five years, the infecting organism proved to be *Ps. aeruginosa*. In view of this, we searched for a substance which would be as effective against the gram-negative group of organisms as the sulfonamide drugs and penicillin are against the gram-positive group.

We shall apply our findings to three essential groups of otologic diseases: (1) acute otitis media, (2) chronic suppurative otitis media and (3) otitis externa.

By far the greatest number of patients treated for infections of the ears have acute otitis media. The infective agent has been variously reported as streptococci in 65 to 90 per cent, staphylococci in 5 to 15 per cent, pneumococci in 5 to 20 per cent and miscellaneous organisms in the remaining ones.<sup>1</sup> It is our belief that all pathologic conditions of ears are due initially to infections, that is, a micro-organism was necessary for the inception of each. This does not discount the fact that anatomic variations and altered physiology may well be a major contributing factor in preventing resolution. Nevertheless, if there were no infective agent, there would be extremely few pathologic ears.

If acute otitis media is diagnosed and treated early in its course with the now readily available armamentarium, resolution takes place within a month, and complications are few. In cases in which complications occur and in which the condition becomes chronic, we frequently note the presence of *Ps. aeruginosa*, against which the newer drugs are not effective. Initially these infections were probably due to the usual streptococci or staphylococci. However, a culture of material removed from an acutely inflamed ear which under adequate modern treatment persists in discharging for more than six weeks will almost always show a gram-negative organism.

Chronic suppuration of the ear always presents a problem, because so many pathologic factors may be involved, such as enlarged or diseased tubal lymphoid tissue, chronic infection of the eustachian tube including stricture and granulation, polypoid tissue of the middle ear cavity and antrum, involvement of the ossicular chain, chronic infection of the membranous lining of the mastoid cells, bony necrosis and cholesteatomatous deposits.

For the treatment of these ears in which pathologic conditions have become chronic, whether the drum has been destroyed or perforated marginally or centrally, extreme cleanliness is a first prerequisite. The infection, as a rule, is deep seated, many cellular layers being involved. These can be treated adequately only with a substance that circulates

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<sup>1</sup> Kummel, W., in Kopetsky, S. J. *Otologic Surgery*, ed 2, New York: Paul B. Hoeber, 1929, p. 6. Woodward, F., in Jackson, C., and Jackson, C. L. *Diseases of the Ear, Nose and Throat*, Philadelphia, W. B. Saunders Company, 1945, p. 282.

through the blood and lymphatic channels and thus reaches every part of the infective process. A medicament locally applied will not do that, its administration must be systemic. There is little question that with local cleansing and removal of excessive tubal tissue, granulation and polyps, many ears will cease discharging for varying periods, but the discharge will often recur. This may be related to the observation of Abraham and Chain<sup>2</sup> and Woodruff and Foster<sup>3</sup> that such gram-negative organisms as *Ps aeruginosa* (*B pyocyaneus*), coliform organisms and *Proteus* produce an enzyme, penicillinase, which destroys the property of bacteriostatic action in penicillin. To combat this, a group of antiseptics were employed which had proved to be active against the gram-negative bacteria, particularly those of the mucoid variety, such as *Proteus* and *Ps aeruginosa*.

We have observed in our present study that local cleansing and systemic medication alone will often result in disappearance of the granulations and in cultures negative for gram-positive organisms but that in many cases the gram-negative forms remain and flourish.

The third variety of otogenic infection is external otitis, which has been shown by many observers<sup>4</sup> and by ourselves to be due predominately to the gram-negative *Ps aeruginosa*. We feel that the concept of otitis externa has changed in recent years. In the past there has been overemphasis on the fungi as the etiologic agent<sup>5</sup>. The present work suggests *Ps aeruginosa* as an important etiologic factor, which in the past was referred to only as the ubiquitous organism which overgrew many of the cultures. The pathogenicity of the organism was generally disregarded. It is our opinion, in light of not only this work but several recent surveys, that the fungi are relatively secondary in importance to *Ps aeruginosa*.<sup>6</sup>

2 Abraham, E. P., and Chain, E. Enzyme from Bacteria Able to Destroy Penicillin, *Nature*, London **146** 837, 1940.

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5 Gill, W. D. Mycotic Infections in Otolaryngology, *South M. J.* **31** 678, 1938. Otitis Externa, *Ann. Otol., Rhin. & Laryng.* **51** 370, 1942. Minchew, B. H., Collins, B. E., and Harris, M. M. External Ear Diseases with Special Reference to the Fungus Type, *South M. J.* **33** 1345, 1940.

6 (a) Salvin, S. B., and Lewis, M. L. External Otitis, with Additional Studies on the Genus *Pseudomonas*, *J. Bact.* **51** 495, 1946. (b) Senturia, B. H. Etiology of External Otitis, *Laryngoscope* **55** 277, 1945. (c) Quayle, A. F. Otitis Externa in New Guinea, *M. J. Australia* **2** 228, 1944. (d) Nelson, R. S. External Otitis in the South Pacific, *Ann. Otol., Rhin. & Laryng.* **54** 367, 1945. (e) Syverton, J. T., and others. Otitis Externa, *Arch. Otolaryng.* **43** 213 (March) 1946.

The problem of otitis externa still remains a complicated one that frequently comes first to the attention of the dermatologist, later it may be referred to the otologist. In this study we have tried to group the cases according to type of otitis—diffuse, furuncular, eczematous and mycotic. Of course, one type often merges with another. Those grouped under the heading of otitis externa diffusa ranged from cases of severe cellulitis to cases in which the canals were chronically wet. Although this is generally considered an acute condition, in which the entire canal is inflamed and edematous, we included cases in which the condition was chronic, in many of which there were acute flare-ups. The cases in which typical "swimmers' ears" were observed fell into this category. Those cases with exfoliation and a tendency toward crusting and exudation, as well as cases of the dry scaling type, we termed "eczematous." Some were undoubtedly instances of seborrheic dermatitis, others were instances of impetigo and intertrigo, but they were all grouped under the heading of eczematous otitis.

As the study progressed, we were surprised to note the frequency of the presence of *Ps. aeruginosa* in ears whose diseases we had felt previously were probably due to fungous infections, and in those with chronic otitis media which had been under treatment. We noted also that only a few of these ears had the greenish pus commonly associated with *B. pyocyaneus* infections. Organisms isolated from these ears and placed in suitable artificial culture mediums did produce heavy pigmentation in many instances. Although we cultured material from only a few normal ears, our results confirm the findings of Syverton and associates<sup>6e</sup> and Salvin and Lewis<sup>6a</sup> in that *Ps. aeruginosa* rarely appeared in normal ears but did appear frequently in pathologic ears. Recent investigators, especially Salvin and Lewis,<sup>6a</sup> Syverton and associates<sup>6e</sup> and Williams and associates,<sup>7</sup> have seemed to corroborate this opinion.

In a group of 100 cases in which external otitis was medically treated, surveyed by Friedman and Hinkel,<sup>8</sup> those in which the involvement was acute, i. e., of less than one week's duration, presented little or no difficulty in treatment. In the group in which the disease was chronic, medical treatment failed in 72 per cent of the cases, and treatment was required for as long as six months in 19 per cent of the cases. Of cases in which external otitis was treated with roentgen rays, 36 per cent were listed as showing failure of treatment, in 20 per cent there were recurrences.

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7 Williams, H. L., Montgomery, H., and Powell, W. N. Dermatitis of the Ear, *J. A. M. A.* **113** 641 (Aug. 19) 1939.

8 Friedman, H. S., and Hinkel, C. L. External Otitis. A Study of the Comparative Merits of Medical and Roentgen Therapy, *Arch. Otolaryng.* **33** 749 (May) 1941.

In our study, material was taken from all ears after thorough cleansing of the conchae and outer auditory canal, but before treatment was instituted, for cultivation. The material was taken with a sterile applicator and streaked on blood agar plates. Sabouraud's medium and thioglycollate mediums were inoculated. Details of cultivation and isolation will not be discussed at length, but the results are shown in tables 1 through 4.

In our search for an agent that would be effective against gram-negative bacteria<sup>9</sup> and, in particular, against *Ps. aeruginosa*, many compounds were tried. The one found most satisfactory in the early part of this work was monobromosaligenin<sup>10</sup>. This substance, used in 5 per cent concentration in polyethylene glycol, proved to be effective against the gram-negative organisms. In the course of this study, dibromosalicylaldehyde<sup>11</sup> proved to be equally effective against the gram-negative organisms, and, in addition, active against fungi.

Dibromosalicylaldehyde is compared with similar fungistatic agents in table 5. It is about ten times as active as the proprietary compounds tested, containing sodium propionate and propionic acid or undecylenic acid and zinc undecylenate.

The antibiotic activity of dibromosalicylaldehyde was checked not only against gram-negative and gram-positive organisms (table 6) but also against the mixed cultures obtained in 6 of our cases (table 7).

#### PROCEDURE WITH DIBROMOSALICYLALDEHYDE

Dibromosalicylaldehyde, prepared in a 15 per cent sodium borate solution, was tested for antibacterial activity. Test tubes containing horse serum (1:10) in pork infusion broth were set up. Dilutions of dibromosalicylaldehyde ranging from 1:200 to 1:12,800 were made, and each was inoculated with a 4 mm loop of a twenty-four hour culture of the test organism. This compound was tested against both gram-positive and gram-negative bacteria. *Staphylococcus aureus* 209 is the standard test strain of the department of agriculture. *Streptococcus C-203* has been used in testing penicillin and the sulfonamide compounds. *Ps. aeruginosa* (*B. pyocyaneus*), *Shigella dysenteriae* (Shiga) and all the other organisms used in the test, other than those of the mixed cultures of this study, were taken from isolations made in the autopsy laboratory at the Johns Hopkins

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9 Contact was made with Dr. John H. Brewer, director of biological research, Hynson, Westcott & Dunning, Baltimore, who was conducting a survey of compounds active against gram-negative organisms. Arrangements were made with him concerning the bacteriologic work and also concerning the several compounds discussed in this paper.

10 This is a preparation of monobromohydroxy benzyl alcohol. It is marketed as "bromsalizol."

11 Dibromosalicylaldehyde is a light yellow crystalline compound, of which the empiric formula is  $C_7H_4O_2Br_2$ . The molecular weight of the compound is 279.934 (hence the compound is called compound 280), and its melting point is 81 to 83°C.

TABLE 1—*Otitis Externa*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
A Patients Treated Initially with Other Preparations and Then with Monobromosaligenin *					
1	5 days	Furuncular	Salmonella morganii	12 days	Resolved
2	6 mo	Diffuse	Staphylococci, streptococci, diphtheroids	26 days	Resolved
3	6 mo	Diffuse	Staphylococci, diphtheroids	30 days	Resolved
4	2 mo	Diffuse	Yeast, E coli, staphylococci, diphtheroids	14 days	Resolved
5	2 yr recurrent	Diffuse	Ps aeruginosa (B pyocyaneus), staphylococci	15 days	Resolved
6	4 mo	Diffuse	Ps aeruginosa (B pyocyaneus), E coli, staphylococci, diphtheroids	23 days	Resolved
7	2 yr in Persia	Eczematous	E coli, beta streptococci, hemolytic staphylococci, diphtheroids	30 days	Resolved
8	4 days	Diffuse	Aerobacter aerogenes, S morгани, staphylococci, diphtheroids	8 days	Resolved
9	5½ yr	Diffuse	Ps aeruginosa (B pyocyaneus), staphylococci, diphtheroids		
10	2 mo	Diffuse	Aerobacter aerogenes, proteus, staphylococci, scarinas	60 days	Resolved
11	6 weeks	Diffuse	Ps aeruginosa (B pyocyaneus), E coli, staphylococci	2 weeks	Resolved
12	1 mo	Diffuse	Ps aeruginosa (B pyocyaneus), hemolytic Staph aureus	19 days	Resolved
13	4 yr	Diffuse	Ps aeruginosa (B pyocyaneus), E coli, staphylococci, gram positive rods	6 days	Resolved
14	1 week	Diffuse	Ps aeruginosa (B pyocyaneus), paracolon bacilli, diphtheroids	21 days	Resolved
15	2 mo	Diffuse	Ps aeruginosa (B pyocyaneus) E coli, beta streptococci, staphylococci, diphtheroids, spore former	3 days	Resolved
16	4 mo	Eczematous	Ps aeruginosa (B pyocyaneus) beta streptococci	3 days	Resolved
17	2 weeks	Diffuse	Ps aeruginosa (B pyocyaneus), beta streptococci, Staph albus, diphtheroids	8 days	Resolved
18	1 week	Diffuse	Both ears Ps aeruginosa (B pyocyaneus), staphylococci, diphtheroids	7 days	Resolved
19	4 yr	Diffuse	Ps aeruginosa (B pyocyaneus), alpha streptococci	8 days	Resolved
B Patients Treated with Monobromosaligenin Alone					
1	20 yr	Diffuse	Beta streptococci, diphtheroids proteus, yeast	14 days	Resolved
2	10 yr recurrent	Eczematous	Staphylococci, Ps aeruginosa (B pyocyaneus)	14 days	Resolved
3	6 mo	Diffuse	Ps aeruginosa (B pyocyaneus), A aerogenes-E coli group, staphylococci diphtheroids	14 days	Resolved
4	2 weeks	Diffuse	Ps aeruginosa (B pyocyaneus), staphylococci	14 days	Resolved
5	1 week	Furuncular	Ps aeruginosa (B pyocyaneus), staphylococci	7 days	Resolved
6	9 mo	Eczematous	A aerogenes, staphylococci	1 day	No return
7	1 mo	Diffuse	Ps aeruginosa (B pyocyaneus), gram positive rods, staphylococci, streptococci	2 weeks	Resolved
8	2 weeks	Diffuse	Hemolytic staphylococci and streptococci proteus	8 days	Resolved
9	1 mo	Diffuse	Ps aeruginosa (B pyocyaneus), beta streptococci	6 days	Resolved

\* This is known commercially as "bromsalizol"

TABLE 1—*Otitis Externa*—Continued

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
B Patients Treated with Monobromosaligenin Alone—Continued					
10	2 mo	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), hemolytic <i>Staph aureus</i>	9 days	Resolved
11	2 yr	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), streptococci, diphtheroids, <i>Staph aureus</i>	2 days	Resolved
12	2 yr	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), beta streptococci, <i>Staph aureus</i>	7 days	Resolved
13	1 mo	Diffuse	Paracolon bacilli, staphylococci	2 days	Resolved
14	22 mo	Eczematous	<i>Ps aeruginosa</i> (B pyocyaneus), <i>E coli</i> , staphylococci, streptococci, diphtheroids	2 days	Resolved
15	2 weeks	Diffuse	Nonlactose fermenter, beta streptococci, hemolytic staphylococci, diphtheroids	5 days	Resolved
O Patients Treated with Dibromosalicylaldehyde					
1	2 weeks	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), beta streptococci, staphylococci	7 days	Resolved
2	2 yr recurrent	Mycotic	Fungi, staphylococci	16 days	Resolved
3	6 weeks	Diffuse, with excoriation	<i>Ps aeruginosa</i> (B pyocyaneus), <i>A aerogenes</i> , gram positive rods in chains, staphylococci, streptococci	21 days	Resolved
4	6 mo	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), staphylococci	7 days	Resolved
5	4 mo	Mycotic	<i>E coli</i> , <i>Aspergillus niger</i>	7 days	Resolved
6	2 weeks	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), beta streptococci, hemolytic <i>Staph aureus</i>	7 days	Resolved
7	3 yr	Diffuse, with acute cellulitis for 2 weeks	<i>Ps aeruginosa</i> (B pyocyaneus), beta streptococci, hemolytic <i>Staph albus</i> , diphtheroids	30 days	Resolved
8	1 week	Characterized by excoriative severe cellulitis ( <i>aspergillus</i> isolated)	<i>As niger</i> , <i>Staph albus</i> , beta streptococci	14 days	Resolved
9	8 weeks	Characterized by exfoliative dermatitis	<i>Ps aeruginosa</i> (B pyocyaneus), beta and alpha streptococci, short gram positive bacilli in pairs, hemolytic <i>Staph aureus</i>	7 days	Resolved
10	2 weeks	Diffuse (green pus)	<i>Ps aeruginosa</i>	3 days	Resolved
11	1 week	Diffuse	<i>Ps aeruginosa</i> (B pyocyaneus), <i>A aerogenes</i> , alpha streptococci		Resolved
12	1 mo	Diffuse	<i>E coli</i> - <i>A aerogenes</i> group, hemolytic staphylococci, alpha and beta streptococci	7 days	Resolved
13	6 mo recurrent	Diffuse	<i>Ps aeruginosa</i>	3 days	Resolved
14		Diffuse	Bacterium bronchisepticum	9 days	Resolved
15	2 yr recurrent	Diffuse	Hemolytic <i>Staph aureus</i>	14 days	Resolved
16	7 weeks	Diffuse	<i>Ps aeruginosa</i> , <i>E coli</i> - <i>A aerogenes</i> group, <i>Staph albus</i> , alpha streptococci	7 days	Resolved
17	7 weeks	Diffuse	Hemolytic <i>Staph aureus</i> , beta streptococci, diphtheroids	1 day	Resolved
18	4 yr	Diffuse	<i>A aerogenes</i> , hemolytic <i>Staph albus</i>	3 days	Resolved
19	3 weeks	Eczematous, with severe excoriation	<i>F coli</i> hemolytic <i>Staph albus</i> , alpha streptococci	12 days	Resolved
20	6 mo	Eczematous	Nonlactose-fermenter beta streptococci, <i>Staph albus</i> , diphtheroids	2 days	Resolved

TABLE 1—*Otitis Externa*—Continued

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
C Patients Treated with Dibromosalicylaldehyde—Continued					
21	4 mo recurrent P W	Diffuse	Aspergillus (white), beta streptococci, Staph albus Ps aeruginosa	6 weeks periodic	Ps aeruginosa persisted, patient did not return
22	3 mo	Diffuse	A aerogenes, hemolytic aerobic gram positive rods	2 days	Resolved
23	6 weeks	Diffuse	Ps aeruginosa, A aerogenes, beta streptococci, diphtheroids	1 day	Resolved
24	2 weeks	Eczematous	Ps aeruginosa, A aerogenes, streptococci, staphylococci	3 days	Resolved
25	4 weeks	Diffuse	Gram positive aerobic spore forming bacilli, beta and alpha streptococci	2 days	Resolved
26	2 mo, twice recurrent in summer	Diffuse	Ps aeruginosa (B pyocyaneus)	3 days	Resolved
27	1 mo	Diffuse	Ps aeruginosa	7 days	Resolved
28	30 days	Diffuse	Alcaligenes faecalis hemolytic Staph aureus	14 days	Resolved
29	3 days	Furuncular	Ps aeruginosa, beta streptococci, hemolytic Staph albus	7 days	Resolved
30	3 yr	Eczematoid	Ps aeruginosa, penicillium, A aerogenes, staphylococci, diphtheroids	30 days	Resolved
31	1 week	Furuncular	Proteus, gram positive rods in chains (seen in thioglycollate broth), beta streptococci, diphtheroids	4 days	Resolved
32	3 weeks	Diffuse	Ps aeruginosa, A aerogenes, long thin gram positive rods, staphylococci	6 days	Resolved
33	3 days	Furuncular	Hemolytic Staph aureus, alpha streptococci	8 days	Resolved
34	8 days	Diffuse	Organism of E coli—A aerogenes group, diphtheroids	7 days	Resolved
35	14 days	Diffuse	Hemolytic Staph aureus, diphtheroids	4 days	Resolved
36	6 mo, recurrent	Eczematous	Ps aeruginosa, alpha streptococci, staphylococci	6 days	Resolved
37	4 mo	Furuncular	Ps aeruginosa	6 days	

Hospital All tubes were incubated twenty-four hours at 37 C and then read Cup-plates prepared according to the standard Food and Drug Administration technic were set up to show the millimeters of inhibition of the mixed cultures obtained by cultivation of material taken from soldiers' ears

#### TREATMENT

Depending on the result of the bacteriologic study, treatment was instituted as follows

1 The patients who had chronically suppurative ears with cultures of predominantly gram-positive organisms were given 20,000 units of penicillin intramuscularly every three hours until the gram-positive organisms disappeared from the culture or the ear was dry In many cases the gram-positive organisms disappeared and the gram-negative organisms, especially Ps aeruginosa, flourished In these cases the

ears were cleansed and irrigated with a 1 per cent solution of dibromosalicylaldehyde once or twice daily, followed by insufflation of a powder consisting of dibromosalicylaldehyde (2 per cent), sodium borate (3 per cent) and talcum (95 per cent)

2 Treatment was instituted in cases of otitis externa immediately after the initial culture was obtained. In all of such cases, regardless of the type of otitis, the ears are cleansed as thoroughly as possible,

TABLE 2—*Chronic Otitis Media*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
A Patients Treated with Sulfadiazine or Penicillin and Then with Insufflation of Dibromosalicylaldehyde Powder					
1	15 yr		Ps aeruginosa, staphylococci, streptococci, diphtheroids	16 days	Dry
2	8 yr recurrent, present at least 1 mo		Paratyphoid B organisms, S. morgani, staphylococci	5 days	Dry
3	33 yr		Ps aeruginosa, hemolytic Staph aureus, beta streptococci	40 days	Dry
4	10 yr		Hemolytic Staph aureus, diphtheroids	2 weeks	Dry
5	5 mo		Proteus, E. coli, Ps aeruginosa, beta and alpha streptococci	30 days	Dry
B Patients Treated with Sulfadiazine and Penicillin					
1	20 yr		Organism of D. coli-A aerogenes group, staphylococci, gram positive spore former	30 days	Improved
2	15 yr		Ps aeruginosa, staphylococci	30 days	Improved
3	20 yr		E. coli, proteus, beta and alpha streptococci, staphylococci, diphtheroids	30 days	Improved
C Patients Treated with Insufflation of Dibromosalicylaldehyde Alone					
1	12 mo		Ps aeruginosa, beta streptococci, staphylococci	1 week	Dry
2	1 yr		Gram negative (Salmonella), beta streptococci, diphtheroids	4 days	Dry
3	8 mo		Ps aeruginosa, A. aerogenes, staphylococci, streptococci	5 days	Dry
4	6 yr	Radical cav	Ps aeruginosa	14 days	Dry
5	4 yr	Radical cav	Ps aeruginosa, alpha streptococci	4 days	Dry

the degree depending on the amount of cellulitis. In cases of otitis externa diffusa, a wick of  $\frac{1}{4}$  inch (6.5 mm) gauze saturated with "carbowax"<sup>12</sup> containing dibromosalicylaldehyde in concentration of 2 per cent is introduced into the canal. This may remain twenty-four to seventy-two hours. Occasionally the patient will complain of a burning sensation, which may persist for as long as three hours. This procedure is repeated and another wick inserted if the clinical appearance

<sup>12</sup> The "carbowax" compounds are polyethylene glycols of high molecular weight.



TABLE 3—*Chronic Otitis Media Complicated by External Otitis*

Case	Duration	Bacteriologic Findings	Length of Treatment	Comment
A Treated with Penicillin and/or Sulfadiazine and then with Dibromosalicylaldehyde				
1	4 yr	Hemolytic staphylococci	28 days	Improved
2	16 yr	Ps aeruginosa, staphylococci, beta streptococci		
3	30 yr	Ps aeruginosa, A aerogenes beta streptococci, staphylococci	14 days	Canal improved but ear not dry
4	6 mo	Ps aeruginosa, Staph aureus, streptococci, E coli	75 days	Dry
5	20 yr	Ps aeruginosa, staphylococci	20 days	Improved
6	4 yr	Ps aeruginosa, alpha and beta streptococci, staphylococci	30 days	Drum healed, canal clear
7	20 yr	Ps aeruginosa, A aerogenes, staphylococci, diphtheroids	30 days	Dry
8	25 yr	Ps aeruginosa, hemolytic staphylococci, streptococci	30 days	Improved
9	26 yr	Ps aeruginosa, Staph aureus, alpha streptococci	14 days	Dry
10	20 days	Staphylococci, diphtheroids	16 days	Dry
B Patients Treated with Dibromosalicylaldehyde Alone				
1	8 yr	Ps aeruginosa, gram positive aerobic spore former, staphylococci	15 days	Dry
2	20 yr	Ps aeruginosa, staphylococci, beta streptococci	4 mo	Dry
3	4 yr	Ps aeruginosa, staphylococci	10 days	Dry
4	2 yr	S morgani, staphylococci	5 days	Not followed
5	19 yr	Hemolytic Staph aureus, diphtheroids	5 days	Dry

TABLE 4—*Normal Ears*

Case	Bacteriologic Findings
1	Hemolytic staphylococci, beta streptococci
2	Gram positive cocci
3	Hemolytic Staph aureus
4	Paracolon bacilli, staphylococci

TABLE 5—*Cup-Plate Test with Five Million Spores of Trichophyton Mentagrophytes\**

Compound	Inhibition in Given Dilution, Mm *				
	1 20	1 200	1 2,000	1 20,000	1 200,000
Dibromosalicylaldehyde	Complete	23 mm	10 mm	8 mm	—
Dibromosalicylaldehyde †	1 50				
	Complete	28 mm	11 mm	Trace	—
Zinc undecylenate and undecylenic acid	1 18				
	15 mm	12 mm	6 mm	Trace	—
Propionic acid and sodium propionate	1 5				
	20 mm	—	—	—	—
Monobromosaligenin	20 mm	2 mm	—	—	—

\* The technic is that described by Emmonds (Am J Pub Health 35 844 [Aug] 1945)

† The bisulfite form was used

suggests further treatment, often one wick is sufficient. In cases of the eczematous type, treatment consists either of insertion of a wick or a simple twenty-four hours local application, followed by cleansing with dry wipes and insufflation of the dibromosalicylaldehyde powder. The powder may be insufflated at daily to weekly intervals, depending

TABLE 6—Antibiotic Activity of Dibromosalicylaldehyde Shown in Dilutions of 10 per Cent Horse Serum Infusion Broth

Gram Positive Test Organism	Dilutions of Dibromosalicylaldehyde						
	1 1,000	1 2,000	1 4,000	1 8,000	1 16,000	1 32,000	1 64,000
<i>Staphylococcus aureus</i> (203)	—	—	—	+	++++	++++	++++
<i>Streptococcus</i> (C 203)	—	—	—	±	++++	++++	++++

Gram Negative Test Organism	Dilutions of Dibromosalicylaldehyde				
	1 800	1 1,600	1 3,200	1 6,400	1 12,800
<i>Escherichia coli</i>	—	—	—	—	+
<i>Proteus</i>	—	—	—	+	+++
<i>Aerobacter aerogenes</i>	—	±	+	++	+++
<i>Pseudomonas aeruginosa</i> (B pyocyaneus)	—	Pellicle	+	++	+++
<i>Shigella dysenteriae</i> (Shiga)	—	—	—	±	+
Friedlander's bacillus	—	+	++	+++	++++

TABLE 7—Antibiotic Activity of Dibromosalicylaldehyde Tested in 10 per Cent Horse Serum Infusion Broth Against Mixed Cultures in 6 Cases

Case	Dibromosalicylaldehyde (1%), Duponol (1%) and Sodium Borate (1 5%)						Cup Plate Containing Dibromo salicylaldehyde (1%)
	1 200	1 400	1 800	1 1,600	1 3,200	1 6,400	
21 (table 1, part O)	—	—	Pellicle ++	++++	++++	++++	Ring shadow of 5 mm in 24 hr, no true inhibition
28 (table 1, part C)	—	—	Pellicle +	++	++++	++++	5 mm. of complete inhibition
29 (table 1, part C)	—	—	+	Pellicle +++	++++	++++	
2 (table 4)	—	—	+	Pellicle +++	++++	++++	Less than 1 mm. of complete inhibition
30 (table 1, part O)	—	—	++	Pellicle ++++	++++	++++	Slight trace of inhibition
3 (table 4)	—	—	++	+++	Flocculent sediment ++++	++++	

on the appearance of the lesions. In those cases in which there may be simply slight weeping, insufflation will suffice. In this study a case of sensitivity to dibromosalicylaldehyde was encountered. The reaction was that of a complicating contact dermatitis. In subsequent observations, not included in this group, another case of sensitivity was encountered.

Of the 71 cases of external otitis studied (table 1), 42 revealed the presence of *Ps aeruginosa*, in the remainder, gram-negative organisms

were usually present. The exceptions were the 2 cases of otomycosis. Only 21 of the 71 cases were of less than three weeks' duration, and in these the otitis responded readily to use of either the original monobromosaligenin or dibromosalicylaldehyde. Even without the initial cleansing of the canal the response to the treatment proved satisfactory. In these cases, for the most part the infection resolved in less than one week. Relief of symptoms often occurred in less than twenty-four hours.

There were 50 cases of chronic external otitis. In many the process was the recurrent type, lasting up to twenty years. In 30 cases the

TABLE 8—*Antibiotic Activity of Monobromosaligenin Against Both Gram-Negative and Gram-Positive Organisms*

Gram Negative Organism	Date	Dilutions of 0.5% Monobromosaligenin plus 1 Cc. of Horse Serum Inoculated with 1 Loop (4 Mm.) of 24 Hr. Culture					
		1:400	1:800	1:1,000	1:1,200	1:1,600	1:2,000
<i>Shigella sonnei</i>	10/5/45	—	—	++	++++	++++	++++
<i>Shigella paradyserteriae</i> (Flexner)	10/5/45	—	—	Flocculent Sediment ++++			
<i>Shigella dysenteriae</i> (Shiga)	10/5/45	—	—	++	++++	++++	++++
<i>Shigella ambigua</i>	10/5/45	—	—	++++	++++	++++	++++
<i>Shigella gallinarum</i>	10/5/45	—	—	+	Flocculent Sediment ++++		
<i>Proteus vulgaris</i>	10/5/45	—	++	++++	Flocculent Sediment ++++		
<i>Salmonella typhimurium</i> Es	10/5/45	—	—	++	++++	++++	++++
<i>Eberthella typhosa</i> (Rawlings)	10/5/45	—	—	+	++	++++	++++
<i>Pseudomonas aeruginosa</i>	10/5/45	—	++	++++	++++	++++	++++

Gram Positive Organism	Date	Dilutions of 0.5% Monobromosaligenin Inoculated with 1 Loop (4 Mm.) of 24 Hr. Culture *				
		1:200	1:400	1:800	1:1,600	1:3,200
<i>Staphylococcus aureus</i> (209) no serum	9/22/45	—	—	—	++	++++
<i>Streptococcus</i> (C 203) with serum	9/22/45	—	—	—	++	++++

\* Marked irregularity was noted in almost every tube of growth. Floaters and precipitate were seen instead of the usual characteristic smooth growth. The results were read at twenty-four hours.

infection resolved in one week or less, in the remainder the ear required two to four weeks' treatment. Two patients failed to return, and 1 patient was seen at infrequent intervals and was classified as a failure. Ten cases were checked bacteriologically after thirty days and the cultures found to be negative. Only 3 patients were seen after six months, although many were followed up to three months. Subsequent follow-up was not possible. With the exception of a case of seborrheic dermatitis, no recurrences were seen. In this case only the local auricular lesion was treated, and it responded promptly.

In the treatment of otitis externa, dibromosalicylaldehyde gave more rapid alleviation of symptoms and final resolution than the original monobromosaligenin

This study included 28 cases of otitis media (tables 2 and 3) With little regard to underlying foci or extent of lesion, the patients were treated systemically or locally, as indicated in tables 2 and 3 It is again interesting to note that in 17 of these 28 cases the presence of *Ps aeruginosa* was discovered, and that only 4 cases suggested that we were dealing with a gram-positive organism as an etiologic agent In many instances, however, penicillin or sulfadiazine had been used before a culture was obtained Twelve of the treated ears became dry in less than two weeks, and 6 of these had insufflation of dibromosalicylaldehyde alone Two cavities resulting from radical mastoidectomies cleared up in less than two weeks In a case of chronic otitis media of four years' duration, complicated by external otitis, complete resolution, with healing of the drum, occurred In the remainder of the cases treatment was required for periods ranging up to two and a half months In 8 of these the ear did not become dry and the patient was separated from the army

#### SUMMARY

In the temperate zone otogenic infections are essentially of two types a winter type, infections due to gram-positive organisms, and a summer type, infections due to gram-negative organisms

The type caused by gram-positive organisms can be treated adequately with the sulfonamide drugs and the antibiotics The type characterized by gram-negative organisms does not respond to these drugs

One hundred cases were studied clinically and bacteriologically (160 cultures)

It was found that the resistant etiologic agent in chronic suppurative otitis media and external otitis was predominantly *Pseudomonas aeruginosa* (*Bacillus pyocyaneus*)

A new compound, dibromosalicylaldehyde, proved to be especially effective against gram-negative organisms, including *Pseudomonas*, and also against fungi

Dibromosalicylaldehyde can be utilized in powder, ointment and solution

Seventy-one patients with external otitis were relieved of symptoms within twenty-four hours In 30 the infection resolved in one week or less, and the rest required two to four weeks' treatment Three cases were classified as failures because the patients failed to return for treatment Although follow-up was inadequate, only 1 patient returned with a recurrence, this one had seborrheic dermatitis

Of 28 patients who had otitis media, 12 had dry ears in two to six weeks, the remainder required up to two and a half months' treatment. Only in 8 did the ears fail to become dry.

In our cases, dibromosalicylaldehyde proved to be an effective agent in the treatment of ears infected with gram-negative bacteria and fungi.

#### COMMENT AND CONCLUSION

This study was begun in 1941, before attention had been drawn to the fact that *Pseudomonas aeruginosa* is an important etiologic factor in chronic infections of the ear. It was this observation which led us to search for a chemical agent that would be more effective against this type of persistent infection. In a carefully controlled bacteriologic and clinical study of 100 cases of otitic infections, a new chemical agent, dibromosalicylaldehyde, has been found more satisfactory than other agents suggested thus far. Owing to the unavailability of streptomycin, no opportunity has been afforded to study the efficacy of this antibiotic in these types of aural infections. Dibromosalicylaldehyde ("dalyde") is a readily available, inexpensive chemical agent, which is effective against both bacteria and fungi.

Dr Lloyd C. Felton prepared the compounds and the various solutions employed in this study, Miss Beatrice Day aided in isolating the organisms from the pathologic aural canals. Most of the clinical work was conducted under the supervision of Col. Harry A. Clark, Medical Corps, United States Army, and Sgt. Thomas Pilon was of assistance in the technical management of the study.

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## LOSS OF SPEECH DUE TO MENINGITIC DEAFNESS

CHARLES E KINNEY, M D  
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DURING the past three years I have had the privilege of studying 29 cases of total deafness due to meningitis. None of the patients gave a history of deafness occurring in the family. I am convinced that all of them had normal hearing at the inception of their meningitis. With the exception of the 3 patients who had meningitis before the age of 12 months, they all had speech normal for their age. The primary purpose of this paper is to study the changes occurring in the speech of such patients. Therefore, I have eliminated all cases in which there was more than residual hearing. By residual hearing, I mean no better hearing than that indicated by a 75 decibel loss up to 500 cycles per second and no response above this frequency.

The literature on this subject is meager. The reason lies in the fact that until the antibiotics began to be used universally in the treatment of meningitis most patients of the type considered did not survive. In 1933 Shambaugh, Wallner, Greene and Shambaugh<sup>1</sup> reported an exhaustive survey of 5,000 children in institutions for the deaf, in which they found 20 per cent with deafness due to meningitis. From my own experience I venture that few of those children were totally deafened. In 1945 Degen and associates<sup>2</sup> reported a survey of 986 cases of cerebrospinal meningitis in England among which there were 27 cases in which total deafness resulted, or 2.7 per cent. In 3 of these 27 cases there was subsequently some recovery of hearing. I have seen 2 patients in whom I felt there was no hearing after their recovery from meningitis but who in from six to eighteen months showed evidence of some hearing. These 2 cases are not included in my series.

In table 1 I have listed these cases with the ages and the vocabularies of the patients as noted when they became deafened, also, the periods elapsed from the times at which the patients recovered from meningitis until voice changes were noticed, and the periods elapsed until there was total loss of speech. It will be noticed that the age incidence is from 10

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Read at the meeting of the American Otological Society, St. Louis, April 22, 1947.

1 Shambaugh, G. E., Wallner, L. J., Greene, L. D., and Shambaugh, G. E., Jr. Severe Deafness in Adults, *Arch. Otolaryng.* **18** 430-448 (Oct.) 1933.

2 Degen, J., and others. Sequelae of Cerebrospinal Meningitis. Follow-Up Study of Nine Hundred Eighty-Six Cases, *Brit. M. J.* **2** 243-247 (Aug. 25) 1945.

months to 26 years, however, 19 of the patients had meningitis within the first three years of life

Eight of the 10 youngest children regained consciousness without speech, although 5 of these 8 had a definite vocabulary of from 5 to 10 words before their illness. The two exceptions are nos 8 and 10, and it is to be noted that both of these had a better than average vocabulary for their age. The next 5 older children had a distinct voice change when they became conscious, and all of these had lost their speech within eight

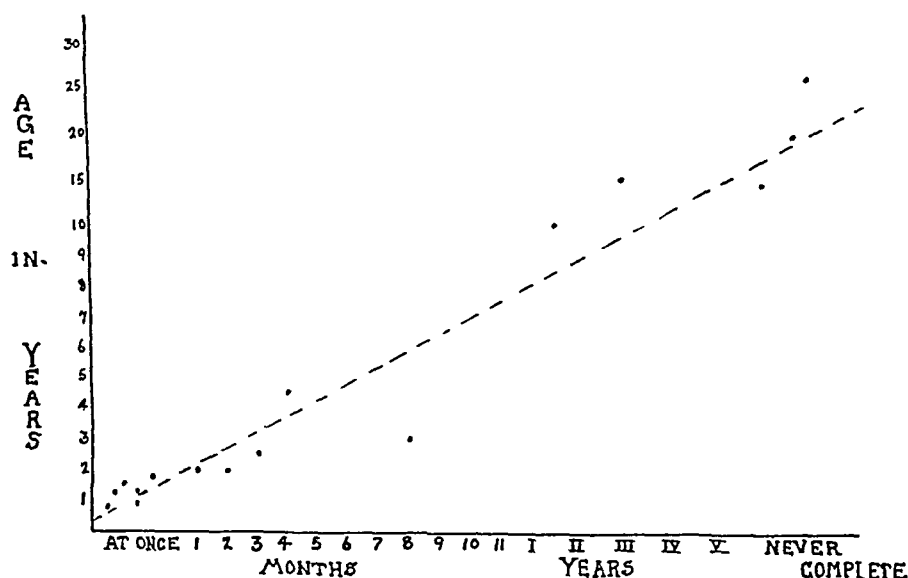
TABLE 1—*Age at Which Meningitis Occurred, Extent of the Vocabulary, Time at Which Voice Change Was Noted with Reference to Recovery from Meningitis and Time at Which Loss of Speech was Complete with Reference to Recovery*

Case	Meningitis	Words	Voice Change	Loss of Speech
1	7 mo	None	At once	At once
2	10 mo	None	At once	At once
3	11 mo	None	At once	At once
4	14 mo	5	At once	At once
5	14 mo	5	At once	At once
6	16 mo	10	At once	At once
7	18 mo	10	At once	At once
8	18 mo	20	3 weeks later	8 weeks later
9	20 mo	10	At once	At once
10	20 mo	20	At once	3 weeks later
11	2 yr	30	At once	10 days later
12	2 yr	30	At once	4 weeks later
13	2 yr	30	At once	8 weeks later
14	2½ yr	Many	At once	8 weeks later
15	2½ yr	Many	3 weeks later	3 mo later
16	3 yr	30	2 weeks later	6 weeks later
17	3 yr	Many	3 weeks later	6 weeks later
18	3 yr	Many	2 mo later	6 mo later
19	3 yr	Many	2 mo later	8 mo later
20	3½ yr	Many	4 weeks later	8 weeks later
21	4 yr	Many	3 mo later	6 mo later
22	4 yr	Many	4 weeks later	1 yr later
23	4½ yr	Many	2 weeks later	4 mo later
24	6 yr	Many	6 mo later	2 yr later
25	10 yr	Many	3 mo later	18 mo later
26	14 yr	Many	3 mo later	Never
27	18 yr	Many	1 yr later	3 yr later
28	19 yr	Many	1 yr later	Never
29	26 yr	Many	3 yr later	Never

weeks. Three of the 4 oldest persons never lost their speech completely. In case 27 the patient had a gradual loss of speech, starting about one year after his recovery, until 3 years later, when he became speechless. In this case I am sure that there was a large psychogenic factor in the patient's becoming speechless, because it was eight months after speech training had been started before he began to speak.

The time elapsing between recovery from meningitis and loss of speech follows a rather definite pattern, as shown in the chart. I have plotted these 29 cases according to the age at which deafness was acquired, along the vertical axis, and according to the time elapsed before they became speechless, along the horizontal axis. The broken line represents a bisection of the average of these two factors.

In table 2 I have listed the ages at which the patients had meningitis, the ages at which speech training was started and the present estimates of their speech. These evaluations were arrived at by combining the opinions of three persons, namely, the child's mother, the teacher and myself. In studying this table, one notices that there are 13 cases in which speech was classified as either very good or good. The patient in case 29 had meningitis at the age of 26 years and never lost her speech. In the remaining 12 cases so classified the average length of time between recovery and the starting of speech training was seventeen months. In the 9 cases in which speech was classified as fairly good or fair, this average time was twenty-seven months. In the 4 cases in which



Loss of speech plotted with reference to age of patient and time after recovery from meningitis

speech was classified as poor or very poor, the average time was thirty-three months. Of course, the length of time that the patient had training alters these figures to some extent, but in general it is apparent that the quicker such patients are started on speech training the better the end result.

It has been interesting to study the bacteria involved in producing total deafness in these 29 cases. I was able to ascertain the causative organism accurately in 21 cases. In 15 cases the condition was due to meningococci, in 3, to *Hemophilus influenzae*, in 2, to pneumococci, and in 1 case, to beta streptococci. The 2 patients previously referred to, in whom total loss of hearing immediately followed the meningitis but who subsequently showed some recovery of hearing had influenzal menin-



gitis In 1937 Eagleton<sup>3</sup> reported that pyogenic meningitis was usually confined to the arachnoid, and any resulting deafness was seldom complete He also stated that deafness following meningococcic meningitis was nearly always complete because the disease involved the blood vessels of the nerves Although I cannot speak about the micropathologic changes in my series of cases, the clinical picture certainly tends to confirm Eagleton's work

Now, I should like to report on one of the most fascinating parts of this study The account is in the form of a preliminary report, because

TABLE 2—*Age at Which Meningitis Occurred, Age at Which Speech Training was Started, and Status of Speech at the Age Given*

Case	Meningitis	Training Started	Speech at
1	7 mo	4 years	6 Fair
2	10 mo	4 years	4 None
3	11 mo	5 years	10 Very poor
4	14 mo	6 years	16 Fairly good
5	14 mo	3 years	4 Very poor
6	16 mo	4 years	17 Good
7	18 mo	3 years	8 Fairly good
8	18 mo	4 years	6 Fair
9	20 mo	3 years	11 Very good
10	20 mo	2 years	3 Poor
11	2 yr	5 years	6 Poor
12	2 yr	4 years	4 None
13	2 yr	5 years	16 Very good
14	2½ yr	4 years	10 Fairly good
15	2½ yr	3 years	4 None
16	3 yr	6 years	16 Good
17	3 yr	At once	5 Fairly good
18	3 yr	8 years	21 Good
19	3 yr	4 years	5 Fair
20	3¼ yr	4 years	7 Good
21	4 yr	At once	5 Good
22	4 yr	5 years	13 Good
23	4½ yr	6 years	7 Fairly good
24	6 yr	7 years	9 Fair
25	10 yr	11 years	12 Good
26	14 yr	15 years	16 Good
27	18 yr	21 years	26 Good
28	19 yr	20 years	48 Good
29	26 yr	Never	55 Good

many of the problems are yet to be solved After the fifth pair of parents voluntarily said that they were positive that their child could hear an airplane in the sky, I became much interested I investigated 3 of the 5 children with respect to this idea, and I am thoroughly convinced that they could appreciate without other warning a two motor airplane flying as high as one mile (1.5 kilometers) in the air With but one exception, the 21 youngest children in this series all seemed to have this ability In 17 cases this information was volunteered without my having asked a question about it

3 Eagleton, W P Suggestions for Prevention of Ocular and Aural Sequelae of Meningococcic Meningitis, Arch Ophth 18 46-49 (July) 1937

Eight of these 20 children were tested with frequencies of from 10,000 to 30,000 cycles per second but seemed to show no response. I was able to study 2 of the 3 children investigated by myself as to their response to twin-engined airplanes with the motors going but not in flight. Further questioning of the other parents convinced me that these airplanes must be twin engined and in flight. After presenting this problem to several eminent acoustic physicists, I received from Mr. Frank Massa, Cleveland, what may be the correct answer. He thinks that it is a combination of Doppler's phenomenon and the beat phenomenon of 2 synchronized airplane motors. The resultant is a frequency of somewhere around 20 cycles per second with fairly high intensity that is appreciated by these children but not by a normally hearing ear. This idea is still being investigated, particularly in studying how the early speech training of such deafened children may be augmented. So far, we have been unable to demonstrate this phenomenon in congenitally deafened children.

#### CONCLUSIONS

1 In cases of total deafness due to meningitis the loss of speech follows a fairly definite pattern, which can be stated as follows. When a person with normal hearing and normal speech becomes totally deaf, he tends to lose his speech to an extent directly proportional to the length of time that he had speech.

2 It is important that speech training be started at once in these cases. This is particularly true with regard to the younger patients, because their memory patterns are not firmly established.

3 Meningococcic meningitis is more likely to produce total deafness than meningitis caused by other types of bacteria.

4 Many of these deafened children have an appreciation of a flying two motor airplane even though all other hearing sensations have gone. This phenomenon is possibly due to subsonic vibrations and may lead to the development of improved methods of speech training for deafened children.

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#### DISCUSSION

DR DOUGLAS MACFARLAN, Philadelphia. Dr. Kinney undertakes a consideration of the most important situation that arises in cases of meningitis after the subsidence of the acute attack, that is, loss of speech.

All should realize how soon speech is lost in these cases, and how hard it is to regain speech or to correct distorted speech. Much depends on the age at which the meningitis strikes, for those with the longest experience of speech and language will show the slower onset of speech damage. That was one of the conclusions which Dr. Kinney mentioned.

Children of 2 and 3 years of age must be put under a trained teacher of the deaf immediately. One should not allow even a period of convalescence without daily practice of speech.

I regret to differ with Dr. Kinney and others whom he quotes as to total deafness in cases of meningitis. He believes that few of the patients are totally deaf. I believe it is rare to find any usable residual hearing. I have found only 3 cases in which there was a remnant, and in those there was not enough to warrant the use of amplified sound. Careful testing will show that many of the patients will report a tactile sensation for hearing, and a tactile sensation will appear at the middle frequencies as low as 80 decibels of loudness. One can and should test to discriminate between the reporting of feeling and what is truly hearing.

The child is trained in a conditioned response and is then tested with an audiometer. Here is such a conditioned response trainer, which I will demonstrate to any one interested. It depends on using a sound loud enough to reach the child's tactile sense. When the instrument is being turned on, the child can be trained to raise the hand to a tactile vibration. Once trained to respond correctly, if he still responds when the machine is attenuated down below the point at which it stimulates the tactile sense he must be reporting as hearing.<sup>4</sup> My associates and I use it because the little deaf child is prone to succumb to complete auditory negation, and attention must be acoustically retrained. Another method to use for children who are profoundly deaf is a sweep type oscillator with an intensity control. If the child truly hears sounds, he will report correctly when a pitch is raised or lowered. Few otologists have such oscillators, so that the best that one can do is to have the child imitate the pitch by humming or whistling.

Remember that audition and the tactile sense overlap at high intensities in the middle range. Remember that children deaf before they acquire language, 2 years old (8 of Dr. Kinney's 29 patients were in this class), do not present the same problem as the child who has some language and memory of speech. More progress can be made in the latter group. If there is usable hearing in either group, a hearing aid must be put on, and memories of sounds built up and maintained.

But most of the patients deaf as a result of meningitis have no usable hearing, and the kinesthetic method must be used to maintain and train speech. Equally important in these cases are the problems of adjustment. Most people who work with the deaf find that these children simply will not adjust to a school routine. Their behavior problems are many and often exaggerated. Among twenty-seven characteristics listed by Louttit<sup>4</sup> as sequelae of meningitis the following are conspicuous: malicious mischief, assaultiveness, lack of inhibition, impulsiveness, indifference, impudence, dominating demeanor, restlessness and inability to accept discipline. Their behavior, Myklebust<sup>5</sup> believes, is due to primary damage of the nervous system rather than destruction of the inner ear. "It seems probable that the higher nerve centers are affected." Thus the behavior problem is practically as important as the speech problem if one is going to make the child fit into this society.

Here, then, is another reason why the child deaf as a result of meningitis should be placed immediately under a trained teacher of the deaf. Otherwise behavior problems will develop as rapidly as will speech disorders.

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<sup>4</sup> Louttit, C. M. *Clinical Psychology*, New York, Harper & Brothers, 1936, cited by Myklebust.<sup>5</sup>

<sup>5</sup> Myklebust, H. R. *Am J Psychol* 59:249 (April) 1946.

As to the speech damages following meningitis in adults, the cases seem to follow no rhyme or reason, and are much like the acquired total nerve deafness seen in the veterans' hospitals. In some cases speech changes appear early and are profound and intractable. In other cases speech does not deteriorate greatly.

All have had the same experience with chronic progressive deafness that has gone on to total loss of serviceable hearing. In some of the patients speech is changed. In others, just as deaf, speech remains unchanged. It apparently is not a matter of residual bone conduction, for each group is equally deficient in bone conduction, as they do not hear their own voices. No one has given the explanation of this.

Finally, again remember Dr. Kinney's warning. Get the child under training immediately.

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## OTOSCLEROSIS

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### An Index of the Literature, with Abstracts, for 1946

THIS is the third instalment of volume IV of "Otosclerosis" to be issued by the Central Bureau of Research of the American Otological Society, Inc.<sup>1</sup> Several foreign articles and others heretofore unobtainable are listed or abstracted herein. Research on correlated subjects, especially if encouraged or supported in whole or in part by the Bureau, will also be included.

In all instances the opinions of the authors are quoted without comment, and the selection of articles implies no endorsement or condemnation thereof. All titles are given in English and the names of all mediums of publication in the language of the original. Dr. Franz Altmann has continued to prepare the translations and outline the abstracts.

Our desire is to publish each year's installment before the end of the following year, but unavoidable delays have made this impossible for 1946.

This instalment, with index of authors according to subjects and perforated for loose-leaf binding in volume IV of "Otosclerosis," may be obtained at cost (\$1.00) from

EDMUND PRINCE FOWLER, M.D., *Editor*

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LITERATURE UNOBTAINABLE AND NOT LISTED IN  
PREVIOUS INSTALMENTS

Nielsen, H E Familial Occurrence of Osseous Fragility, Blue Sclera and Deafness, *Nord med (Hospitalstid)* 15 2203, 1942

de Gunten, P Is It Possible to Cure Otosclerosis with A T 10 (Results of Patho-Anatomical Experiments)? *Schweiz med Wchn-sch* 73. 77-79, 1943

By injecting dihydrotachysterol ("A T 10") into rats the author succeeded in producing generalized changes of the skeleton, consisting in general osteoporosis with fibrosis of the marrow. The changes were found in all of the three layers of the labyrinthine capsule. The lesions resembled certain stages of human osteitis fibrosa. Similar results were obtained by Seiferth and Kolb (1938, 1939) in rabbits. These authors assume that the experimental changes are analogous to those in human otosclerosis. They believe that the experiments prove that otosclerosis has a uniform causation and is due to changes in the parathyroid gland, therefore, they introduced the aforementioned preparation of dihydrotachysterol as treatment directed at the cause of otosclerosis.

According to de Gunten, however, there are essential differences between the experimental lesions and human otosclerosis. The reparative phase (formation of new immature bone and other processes) is entirely missing, and ankylosis of the stapes does not occur. The lesions affect the labyrinthine capsule uniformly and are not more marked at the places of predilection for otosclerosis. The author points out that osteoporosis with fibrosis of the marrow is a nonspecific reaction of the skeletal system elicited by various and different metabolic disturbances.

The changes produced by dihydrotachysterol have nothing to do with otosclerosis. The fact that marked changes in the labyrinthine capsule could be produced by a metabolic disturbance favors the assumption that a still unknown metabolic disturbance could be the cause of otosclerosis. It does not, however, justify the use of dihydrotachysterol as etiologic treatment of otosclerosis.

Bustamante Gurria, A Otosclerosis Surgical Therapy, *Prensa méd* *mer* 10 74-75 (Aug 15) 1945

The article consists of a general discussion and a review of the problem.

**Corrêa Netto, O , and Mourão, B M** Otosclerosis and Nicholas-Favre Disease Contribution to Study of Etiology, *Rev brasil de otolimo-laring* 13 128-138 (March-April) 1945, *Rev med e cu de São Paulo* 5 93-101 (March-June) 1945, *Brasil-med* 59 192-196 (May 19-26) 1945

Among 10 cases of otosclerosis there were 9 in which the Frei reaction was positive, while, at the same time, in 15 cases of other diseases the reaction was negative Attention is directed to this high incidence The authors think that the virus of venereal lymphogranuloma could have entered the labyrinth and could have caused the deafness If this is true, then the Frei reaction could lead to an early diagnosis and an early treatment of otosclerosis

**Díaz-Caneja, E** Blue Sclerotics in Osteogenesis Imperfecta (Lobstein-Vrolik Disease), *Arch Soc oftal hispano-am* 5 630-655 (Aug) 1945

This article to date has been unobtainable

**Gomensoro, J B , and Isola, W** The Syndrome of Blue Sclera, *Rev oto-neuro-oftal* 20 111-119 (Sept-Oct ) 1945

The authors describe the case of a man of 27 years with blue scleras, multiple fractures and bilateral high tone loss of hearing They think the high tone loss could be due to changes within the mesenchymal tissues of the inner ear The symptoms and the pathogenesis are described Disturbances of the endocrine system or anomalies of the mesenchyme are regarded by most authors as the possible etiologic factors

**Holmgren, G** Problem of Otosclerosis, *Nord med* 25 287-290 (Feb 16) 1945

This is a general review of the problem The classic clinical picture is described Only the surgical treatment has proved of value, although the improvement of hearing is often only temporary

In routine histologic examinations it has been shown that 10 per cent of the population harbor otosclerotic foci In a majority of the cases there is no ankylosis of the stapes In properly selected cases there is, on opening of the labyrinth, an immediate improvement of hearing as soon as perilymph flows out One creates a new window in the lateral semicircular canal, and the improvement of hearing lasts as long as this window stays open The author believes that in otosclerosis there is an increase of intralabyrinthine pressure

It is too early to decide whether the operation suggested by Wittmaack actually arrests otosclerosis

Otosclerotic patients show certain symptoms, such as absence of the cerumen of the external canal (50 per cent of the cases), decreased tickle reflex, wide canal, impaired mobility of the handle of the hammer (75 per cent of the cases), abnormal transparency of the drum membrane and abnormal mobility of the pars tensa (50 per cent of the cases) Ankylosis of the stapedial foot plate leads to impairment of the mobility of the ossicles, with dislocation and changes of the joints

Histologically, blue mantels are found frequently in the bone of the ossicles, and in one case Covell found otosclerotic foci in the malleus and the incus

Impaired movement of the handle of the hammer interferes with the proper nutrition of the drum membrane with subsequent atrophy of the latter and of the skin of the meatus

The author believes that increased intralabyrinthine pressure, even without ankylosis of the foot plate, will cause outward bulging of the round window membrane and will produce conduction deafness because it actually leads to fixation of the foot plate and of the chain of ossicles The studies of the changes occurring in the ossicles, the drum and the meatus in otosclerosis open up an entirely new field of research

**Mourão, B M** Possible Etiologic Relations Between Otosclerosis and Nicholas-Favre Disease, *An paulist de med e cir* 50: 305-307 (Oct) 1945

# INDEX OF LITERATURE OF 1946, WITH ABSTRACTS

**Altmann, F** Healing of Fistulas of the Human Labyrinth Histo-pathologic Studies, *Arch Otolaryng* 43 409-421 (April) 1946

The author's summary and conclusions follow

An incomplete bony closure of a fistula of the lateral semicircular canal was observed three years after operative injury

The findings in this case were analyzed and compared with those in 19 cases collected from the literature

In the cases in which a spontaneous fistula had stayed open, the bone had been destroyed very gradually and with a minimum degree of irritation by a slowly growing cholesteatoma The outer surface of the fistula was covered with stratified squamous epithelium, and the endosteum was normal or thickened but not destroyed

Infection and hemorrhages in the area of the fistula, destruction of the endosteum and presence of bone chips left behind are the most important factors that promote bony closure of the fistula Epithelium on the outer surface of the fistula, particularly stratified squamous epithelium, exerts a retarding influence on bone formation

In contrast to the findings in spontaneous fistulas, rapid bony closure of the vast majority of the fistulas created in fenestration operations took place when the fibrous endosteal membrane had been left intact This is explained by the



fact that in operative fistulas there is an accumulation of blood and inflammatory exudate in the narrow space between the endosteum and the skin flap with subsequent formation of osteoporetic tissue. In spontaneous fistulas these changes are absent, and the process comes to a standstill when the endosteum has been reached.

The experience gained in fenestration operations, particularly the observation that the fistula in the ampulla of the lateral canal or in the surgical dome of the vestibule shows less tendency to bony closure than one over the canal proper, is confirmed by the anatomic findings in some cases of nontraumatic fistula. The correlations and the differences are explained not only by the effects of the larger size of the perilymphatic space in the vestibule but also by the local differences in the osteogenic activity of the newly formed connective tissue in various parts of the labyrinth.

**Anson, B. J.** Saccular Diverticula in the Membranous Labyrinth of Mammalian Embryos, *Quart Bull, Northwestern Univ M School* 20 421-423, 1946

Certain aberrant evaginations of the saccule of the fetal ear are described, as part of the course in studies of the otic labyrinth.

**Anson, B. J., and Bast, T. H.** The Development of the Auditory Ossicles and Associated Structures in Man, *Ann Otol, Rhin & Laryng* 55 467-494 (Sept) 1946

**Anson, B. J.** Development of the Auditory Ossicles, *Laryngoscope* 56 561-569 (Oct) 1946

A study of more than 250 series of sections has been completed to establish the major steps by which the auditory ossicles develop into adult form.

The results of the study may be summarized as follows:

The ossicles follow a remarkable series of developmental steps in attaining adult form—a circumstance which might be expected when it is considered that they are made over to serve, in higher vertebrates, a function very different from their primitive office.

The malleus and the incus are developmentally less aberrant than the stapes. Yet they differ from bones generally not only in possessing a peculiar form but also in lacking epiphysial centers of growth, in having a single ossification center each and in attaining adult size and shape in the fetal body.

The stapes, in addition to displaying the features just named, is unique in the following respects: each crus (corresponding to the shaft of a long bone) becomes channeled to resemble a long bone halved lengthwise, with concurrent sacrifice of its marrow and invasion by mucous membrane and submucosal tissue; the head is likewise excavated and the base reduced to a thin plate of either oval or reniform outline.

Since the ossicles attain maturity while the remainder of the skeleton is still fetal, the opportunity for structural alteration is great. Since they are remodeled elements—having been profoundly altered to make up an ossicular chain—variation is to be expected, and does regularly occur.

These observations must be taken into account in any appraisal of pathologic change occurring in the ossicles. Without knowledge of the kind briefly reported here, normal departure from the so-called typical form could be erroneously interpreted as the result of disease.

**Barnett, H. N.** Otosclerosis, *M. World* 63: 812-814 (Feb. 8) 1946

The author reviews briefly the various aspects of the disease for the general practitioner.

**Bast, T. H.** Development of the Aqueductus Cochleae and Its Contained Periotic Duct and Cochlear Vein in Human Embryos, *Ann. Otol., Rhin. & Laryng.* 55: 278-297 (June) 1946

The development of the aqueductus cochleae and the periotic duct is traced through the developmental stages. The difference between the periotic duct and the aqueductus cochleae is explained. The periotic duct, a channel filled with a loose arachnoid-like tissue, is already clearly indicated in a 9 week (40 mm) embryo. Already at this early stage its one end communicates with the scala tympani and its other with the arachnoid. In fetuses and infants it does not have a continuous epithelium-lined lumen but is filled with a loose arachnoidal connective tissue.

When the otic capsule ossifies the periotic duct becomes surrounded by the periosteum of the surrounding bone. This bony channel, with its periosteum and the contained periotic duct, is known as the aqueductus cochleae. The vein of the aqueductus cochleae for the most part occupies a bony channel of its own and is not in the aqueductus cochleae.

The periotic duct is a slowly tapering channel. It is widest at its cranial end and narrows in its course toward the scala tympani but widens before it enters the latter.

**Campbell, A., de Villiers, A. J., and Kerr, W. A.** Fenestration for Otosclerosis, *South African M. J.* 20: 252-254 (May 11) 1946

Campbell opposes the transtympanic approach because he thinks that with the "square-on" approach "it would be extremely difficult in the living patient to make a window without damaging the underlying structures even with a minute trephine or adapted dental burr. Lempert's approach seems to be much safer."

De Villiers questions whether the blood supply of the reflected tympanic membrane will be sufficient to maintain nutrition of the

membrane and save it from complete destruction. He stresses the danger of suppurative labyrinthitis and meningitis should acute otitis media occur when transtympanic fenestration has been performed. This danger is avoided with Lempert's technic, in which the attic is completely separated and shut off from the tympanic cavity.

Kerr objects to an enthusiastic report about Dr. Popper's approach which has appeared in a South African newspaper.

**Day, K. M.** Appraisal of Fenestration Operation. Report of One Hundred Cases, *Arch Otolaryng* 44: 547-559 (Nov.) 1946.

The author uses the following modifications of the standard technic:

1. He does not remove a wedge of tissue between the tragus and the helix but simply employs a single line incision in this area. It begins at the outer superior margin of the external meatus and is carried upward anterior to the border of the helix far enough to provide an adequate operating field. This incision is made down to but not into the temporal muscle. At the end of the operation it is closed with sutures or clips. This eliminates most of the postoperative pain and discomfort, which means less inflammatory reaction.

2. Partial mastoidectomy only is performed, with just sufficient cellular bone being removed from around the mastoid antrum to provide adequate working space.

3. The use of melted paraffin to fill the cavity at the end of the operation is discarded. Instead paraffin gauze is used, whereby several small pledgets are packed snugly but not tightly over the flap to hold it in position. No attempt is made to stretch the flap or to put tension on it in order to get the thinnest portion over the fenestra. The packing is entirely removed on the fifth day.

There were no serious postoperative complications, such as facial weakness, operative infections or dead labyrinth. Among the 90 patients operated on with Lempert's nov-ovalis technic 76 regained practical hearing, 4 had an unsatisfactory result, 6 showed no improvement, and in 4 the loss of hearing became worse. The fistula closed in 8 of these patients. There were 6 revisions, 3 of which were successful and resulted in practical hearing.

There have been seven pregnancies in this series since operation with no appreciable loss of hearing in either the ear operated on or in the one not operated on.

**Fine, J.** What Is New in Otosclerosis? *South African M J* 20: 748-749 (Dec. 14) 1946.

This is a general review of the problem, with a discussion of the diagnosis of otosclerosis and of the fenestration operation.

**Fowler, E P** A Report of Progress Twenty Years' Research in Otosclerosis Progressive Deafness and Correlated Problems, 1926-1946, Central Bureau of Research, American Otological Society, Inc., 1946

A report of the research aided by the Central Bureau is given in an illustrated booklet expressing the modern conception of the problems of otosclerosis

**Fowler, E P** The Value of Individual Hearing Aids for Haid of Hearing Children in Public Schools Report to the Sub-Committee of the Committee on Problems of Deafness of the National Research Council, the Otological Examination and Follow-Up, *Laryngoscope* 56 26-32 (Jan ) 1946

The primary purpose of the otologic examination of these children was to match them in pairs according to similarities in degree and type of hearing loss, also, these pairs were to be matched as nearly as possible from the point of view of psychology Over 250 children were examined by the author, and 100 of these were chosen for pairing Fifty-two children were paired (26 pairs) The one child was provided with a hearing aid, and the other was not The 48 remaining children were not closely pairable, but half of them were supplied with hearing aids One extra child was used as a "spare"

All of these children had been tested at least once previously with both 4-A and 2-A audiometers in the public schools The tests were made in an efficiently soundproofed room in the author's office, the examinations and tests were repeated at least once a year over a period of three years (12 children had only two tests)

Fowler's method of weighting as adopted by the Consultants on Audiometers and Hearing Aids of the American Medical Association was used, but no allowance was made for the recruitment phenomenon or the variable ratio between the two ears Otherwise, the percentages of loss of capacity were obtained by using Fowler's method The author made exhaustive otologic examinations, the results of which are listed The most spectacular gains in hearing were obtained in the cases of pure obstructive deafness in which there was no more than a 30 per cent loss at the first testing

A scatter chart shows the distribution of the losses and the subsequent gains and losses Diagnostically, the cases fell into four main groups

Pure nerve deafness	8
Nerve deafness with some obstructive deafness	57
Obstructive deafness with some nerve deafness	5
Pure obstructive deafness	31

The statistician, Dr Irving Lorge, reports

It is significant that the variation in hearing among individuals is greater than the variation between the means of the aid and the no-aid groups respectively, but the variation among individuals is so great that it obscures any genuine differences between groups

The variation in the gains of individuals is so variable that any distinction between aid and no aid cannot be clearly revealed with the number of cases utilized in this experiment

The data which stand out most sharply are (1) the number of children who improved to some extent (namely, 78 per cent), compared with the number who lost to some extent (namely, 22 per cent), (2) the number who improved over 20 per cent (namely, 22 per cent) (3) the number who at the last test showed less than a 30 per cent loss (namely, 39 per cent), and (4) the number who were deafened (to some extent at least) from auditory neural lesions (70 per cent) It is evident that at least one third of the children showed a marked improvement in hearing (About 40 per cent improved to the 30 per cent loss level)

The distance at which the soft voice was heard varied directly with the per cent gain or loss of capacity to hear the speech frequencies

"Had some special 'cure' for deafness been employed, these statistics might be used to show that the 'cure' was responsible for the remarkable 'restorations' of hearing Obviously any such claim would be unwarranted"

Fox, G M Fenestration for Otosclerosis, *South African M J* 20: 479-481 (Aug 24) 1946

The author reviews the methods used for the preoperative examination of the patients and the operative technic which he studied during a recent visit to the United States He reports that fairly successful results were obtained in from 40 to 50 per cent of the cases in which the operation was done

Greenfield, S D An Evaluation of the Lempert Fenestra Nov-Ovalis Operation in the Treatment of Otosclerosis Report on Thirty-Six Patients Who Were Selected for This Operation, *Arch Otolaryng* 43. 25-30 (Jan ) 1946

The author comes to the following conclusions

1 The Lempert fenestra nov-ovalis operation is the only form of treatment for the restoration of serviceable, practical hearing in patients with otosclerosis

2 No man should attempt the operation unless he has spent sufficient time studying and preparing himself for this work under competent instruction

3 The operation is a safe procedure in the hands of those especially trained to do the operation

4 The patients most suitable for operation are those suffering with the purely conductive type of deafness without any evidence of nerve involvement

Hagens, E W Pathology of Otosclerosis, *Quant Bull, Northwestern Univ M School* 20. 192-198, 1946

The problem is reviewed

Characteristic of otosclerosis, foci occur in localized patches, and with hematoxylin and eosin stain the pathologic bone stands out, usually staining quite intensely. Some authors have believed that this staining reaction is due to the excess of calcium in the foci so that even after decalcification there would be sufficient calcium to produce a deeper stain with hematoxylin. Another view has been that a peculiar chemical characteristic of the ground or cement substance in the focus produces the peculiar reaction. Experiments by the writer have shown that it is the unusual affinity of the focus for the alum of the mordanted hematoxylin that results in the deeper staining reaction. No proof for the theory of excess calcium in the foci was found in tests using alizarin and purpurin.

The so-called nerve degeneration frequently found clinically in cases of otosclerosis does not manifest itself in morphologic changes in the inner ear or the cochlear nerve. The author was unable to confirm the findings of Gray regarding the loss of neurokeratin in the cochlear fibers.

Hall, I S The Surgical Treatment of Deafness, *Irish J M Sc*, March 1946, pp 80-84

This is a general review of the question. The author describes Lempert's fenestra nov-ovalis technic without stopple. He emphasizes, however, that there is no essential difference between the endaural and the postauricular approach. He prefers the latter. For making the fistula he uses a dissecting microscope with a magnification of 6 to 8 diameters.

Hall, I S The Fenestration Operation for Otosclerosis, *Brit M J* 2: 647-649 (Nov 2) 1946

The purpose and the indications for the fenestration operation are discussed. Lempert's fenestra nov-ovalis technic is described, and reference is made to the equipment necessary for its performance. Out of 118 patients operated on eight months or more ago 82, or 69 per cent, still show an improvement, the degree of which is not stated. There were two fatalities. One patient, an elderly woman, died of acute cardiac collapse shortly after the operation was completed. Another, a man of 43, died of acute morphine poisoning some hours after the operation. He had received the usual dose of postoperative sedative. Pregnancy has occurred in several patients, and its effect has been variable. In some cases there has been a definite loss of hearing, in others, no change.

**Kobrak, F** Contributions to Functional Pathology IV Clinical Notes on Progressive Congenital Deafness *J Laryng & Otol* 61 49-91 (Feb) 1946

The author's conclusions follow <sup>2</sup>

1 Otosclerosis is considered from the viewpoint of a primordial form of progressive congenital deafness. There appear to be three genetically distinguishable forms of progressive congenital deafness, the descendants of the primary "primordial otosclerosis" [a] osseous otosclerosis, [b] progressive cochlear deafness, and [c] a compound of otosclerosis with progressive cochlear deafness. The well known perivascular osseous changes [in otosclerosis] are regarded as the cause of ischemic lesions in the organ of Corti. This occurs in the individual cases, [however] it becomes of genetic importance with mutation. The eventualities of [the] genetic splitting up provide a genetic explanation of the commonly accepted view that otosclerosis and progressive cochlear deafness are varieties of the same condition.

2 The diagnostic significance of vestibular signs in progressive congenital deafness depends on the detection of changes in the "mute area" of the petrous bone, and, so, of conditions suggestive of latent congenital deafness. Vestibular tests are therefore regarded as an indispensable part of functional tests for progressive congenital deafness, especially for early diagnosis.

3 Detailed vestibular and some new auditory tests indicate certain changes in progressive congenital deafness which are common to both otosclerosis and progressive cochlear deafness and make the clinical picture of progressive congenital deafness more intricate than it appeared to be when [it was] based solely on the old routine auditory tests. Thus a certain confusion and diagnostic deadlock arose, in the field of clinical otology, analogous to a certain pathological-anatomical confusion due to advancing histological research on changes in progressive congenital deafness which, like the clinical findings, are also common to both otosclerosis and progressive cochlear deafness. However, the histological observations when compared with our new clinical findings seem to corroborate each other. A clue to the clarification of the cloudy diagnostic situation is suggested [by certain] laws of genetics [vide conclusion 1].

4 According to our clinical observations the old classical form of predominantly ankylotapedial otosclerosis is less frequent than other forms of otosclerosis in which ankylotapedial signs are not predominant or not even detectable. The manifest form or some concealed forms of "basal cochlear otosclerosis" are of importance. These clinical conclusions are much in accordance with pathological-anatomical findings of other authors.

5 The therapeutic approach to prophylaxis is the same for the diverse forms of progressive congenital deafness, less because of their genetical identity than because therapy and prophylaxis can so far be directed only against an abnormality which is obviously common to both clinical otosclerosis and progressive cochlear deafness. [It does this] by combating abnormal activity in the tympanic muscles.

6 Progressive congenital deafness shows several types of behaviour of prognostic importance. These may be graded in an "order of congenital types" of deafness. The locus of the individual type of congenital deafness in this order

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<sup>2</sup> In quoting the article the reviewer has made certain slight changes aimed at clarifying the presentation.

seems to reveal some clinical signs with prognostic implications as to the severity of the lesion

**Lindsay, J R** Histologic Observations on Healing of Labyrinthine Fistulas (Produced by Fenestration Operation) in Monkeys, *Arch Otolaryng* 43: 37-48 (Jan ) 1946

The author reports the results of experiments carried out on a series of 48 monkey ears. He offers two conclusions regarding the regeneration of bone

1 The fistula in the bony semicircular canal always closes by formation of new bone unless certain measures are carried out

2 The regeneration of bone occurs rapidly from the periosteal layer and more slowly from the endosteal surface of the capsule. Complete closure may occur from either or both layers

Attempts to prevent regeneration of periosteal bone resulted as follows

- 1 The use of a cutaneous flap reflected from the posterior wall of the external auditory meatus without removal of the annulus tympanicus was not successful. The situation of the fistula in a concavity tends to prevent close contact with the covering flap throughout the healing period
- 2 Thiersch grafts of hair-bearing skin were frequently successful in preventing closure for several months but proved to be unsatisfactory because of occasional degeneration and because of the presence of hair fragments beneath the graft, which stimulated formation of callus and eventual closure
- 3 Conjunctival grafts were used with a sufficient degree of success to warrant further laboratory investigation
- 4 The use of a tympanomeatal flap according to the Lempert technic has given the best results as indicated by the response to the test for fistula

Commenting on the application of any covering graft or flap, the author states

A factor predisposing to success is the locating of the fistula on a convex surface rather than in a localized concavity. Such a site is obtainable slightly distal to the ampulla when the posterior bony wall of the external auditory meatus and the rim of the annulus tympanicus are adequately removed. The evidence suggests that any fistula remains open only by virtue of the union which occurs between the membranous labyrinth and the covering flap to the exclusion of osteogenic tissue. The perilymphatic space always becomes separated from the covering flap either by a layer of new bone or by the membranous labyrinth. Measures necessary to permit fibrous union between the membranous labyrinth and the covering flap have been shown to be

1 Bone fragments and endosteum must be completely removed from the fistula

2 The normal contour and position of the membranous canal must be preserved so that it makes uninterrupted contact with the covering flap

Failure in this was commonly caused by allowing bone fragments to slip between the bone and the endosteum or between the endosteum and the membranous canal



and by injuring or rupturing the membranous canal so that it became depressed or displaced

**Maybaum, J L** Status of the Fenestration Operation for Otosclerosis  
Presentation of Permanently Improved cases, *J Mt Sinai Hosp*  
13 1-5 (May-June) 1946

The author reviews the problem. An improvement of hearing which has been maintained for one year after a fenestration operation may be regarded as permanent. This statement is based on the collective experience of a few thousand cases in which this operation was performed. Three cases are discussed in which hearing was thus permanently improved, the gain having been maintained for twenty-six months in 2 and for thirty-two months in 1. By means of the fenestration operation (the fenestra nov-ovalis technic of Lempert) and proper selection of cases of otosclerosis, a "successful outcome" may be expected in 70 to 85 per cent of the cases. Failures result from poor selection of cases, faulty technic, overactive osteogenesis and postoperative labyrinthitis.

**Prienaar, P de V** Fenestration and Early Hearing Improvement  
Case Record, *South African M J* 20 405-409 (July 27) 1946

The author reports the results of audiometric examinations of a 30 year old woman made before and fourteen days after a fenestration operation for otosclerosis. The operation was performed by Dr O Popper. The transtympanic approach was used, and a cartilaginous stopple was placed in the window. At frequencies below 2048 cycles per second an increase of hearing acuity was found, varying from 45 decibels at 128 cycles to 10 decibels at 2048 cycles. At 4096 cycles the threshold dropped 15 decibels below the preoperative response. The author was surprised to find a more or less level gain for all frequencies in the ear not operated on.

**Popper, O** Fenestration of the Labyrinth. I The Transtympanic Route *J Laryng & Otol* 61. 24-37 (Jan) 1946

Before the fenestration operation can hope to enjoy popularity and to be performed with the essential degree of competence by a large number of otologists, a complete reorientation of ideas concerning the surgical approach to be made to the vestibule must take place.

To approach tympanic structures through the mastoid process seems a surgical absurdity, and "until otologists come to grips with this anachronism, so long will this operation remain in the hands of the very few."

The transtympanic approach offers many advantages, such as "square-on" presentation of the operative field, easy access, perfect

hemostasis, superlative landmarks, perfect visual control, shorter duration of the operation and less operative trauma and postoperative reaction. The author's description of his technic follows, with some necessary condensations in the brackets

[Up to the point of fenestration local anesthesia, with heavy premedication, is used, when the actual fenestration begins, pentothal sodium is given intravenously]

The skin incision is over the tragus or in the fold between the tragus and the temporo-mandibular articulation, [it is about  $1\frac{1}{2}$  in (3 to 4 cm) long] The skin is reflected off the cartilage of the tragus, and blunt dissection is carried over the anterior surface of the cartilage of the meatus and the latter's attachment to the tympanic plate. Further blunt dissection clears the bone of the anterior surface of the tympanic plate until the latter is exposed for  $\frac{1}{2}$  inch. No vessels, nerves or other structures of consequence are encountered. The tissues are retracted forward *en masse*, pushing the temporo-mandibular articulation with them.

[A second incision is made through the attachment of the cartilage down to the tympanic plate] and through the underlying skin, thus opening into and revealing the divided lumen of the meatus itself. A rongeur of suitable size is now inserted into the bony meatus, to grasp and remove a large part of the tympanic plate and its investment of skin.

[Now] with side cutting dental burrs the upper, lower and deep edges of the partly removed tympanic plate are trimmed until the entire wall down to the tympanic ring at the insertion of the drum is cleared. The drum now stands clearly revealed and, be it noted, "square-on" and not obliquely sloping away as when viewed through the meatus.

The next step is the detachment of the drum with adjacent meatal skin—or the fashioning of the tympanomeatal flap. [The latter should cover the area above the fenestration, but should not be too large] After infiltration an incision is made in the skin of the meatus down to the bone, somewhat less than half an inch

from the drum [membrane, and] around the remaining part of the meatus. This partial cuff of skin is reflected from the bony wall down to the tympanic ring, from which it is carefully detached with gentle strokes of a fine curette so that the skin, plus the drum [membrane], can be reflected forwards as one continuous whole over the handle of the malleus. The contents of the middle ear now stand revealed. The ampulla dome region [of the labyrinth] is still overhung

by the lateral wall of the attic. [The latter is now removed with dental burr, and in this way the incus is exposed] The incus is now removed, [the head of the malleus is not amputated because it does not obstruct the view. Now the surgical dome of the vestibule is opened with a diamond paste burr of 2 mm diameter which produces a circular hole in the bone. Suction irrigation is used. A piece of cartilage is taken from the tragus and inserted into the fistula. Then the tympanomeatal flap is turned over the fistula and tucked well in with paraffin ribbon gauze impregnated with sulfanilamide and penicillin. The first dressing is done on the seventh day.]

The tympanomeatal flap and the exposure of the attic by the transtympanic route offer an alternative to the radical operation for chronic otorrhea due to attic-antral disease.

Instead of the surgical dome of the vestibule the "cochlear vestibule" may be fenestrated. The cochlear vestibule is the part of the vestibule which lies above the basilar membrane and above the lamina spiralis ossea.]

The transtympanic technique is carried through up to the completion of the tympanomeatal flap. The attic wall is left intact. The malleus is gently displaced forward until a space in front of the anterior crus of the stapes is cleared on top of the "shoulder of the promontory," which is parallel to and below a line continuous with the tendon of the stapedius. The fenestration should lie on, but not cross, the horizontal tangent of the upper curvature of the round window. [The fenestration is done with a diamond paste cylinder 1.5 mm in diameter. The window may be closed with a piece of cartilage.] The "cochlear vestibule" is remote from the nerve supply to the ampulla, saccule and utricle. These nerves ramify in the dome of the vestibule to supply the respective parts of the labyrinth. Post-operative labyrinthine disturbances may, therefore, be expected to be less severe and more evanescent than when fenestration takes place immediately adjacent to these nerves at the ampulla and dome, as there is less liability to trauma.

[Fenestration of the vestibule, the author states, will succeed in restoring hearing only if the round window membrane is functionally unimpaired. He believes that cases of otosclerosis with a "low cochlear nerve function reserve" are caused by impaired function of the round window membrane, which leads to decreased mobility of the perilymph. This prevents the vibration from reaching the upper region of the cochlea. Thus the latter receives "no stimulus, and does not respond to sounds in the upper register, despite the fact that the nerve endings in the spiral organ are functionally unimpaired. Closure of the round window could produce such a situation."

"Fenestration of the scala tympani, alone or in addition to vestibular fenestration, may prove effectual in such cases of profound mixed deafness. These procedures" are, however, still "in an experimental stage."

The author believes that closure of the round window would produce the same symptoms as fixation of the stapes and that a test for round window closure is imperative. "The site for fenestration of the scala tympani must lie below the attachment of the basilar membrane. If a tangent be drawn  $30^\circ$  to the horizontal touching the upper curvature of the fossula of the round window, the site of fenestration lies below and behind this line, and between it and the lower curvature of the round window. The attachment of the basilar membrane within the promontory wall lies above and in front of this area"]

Cawthorne's operation for Meniere's disease and Wright's method of injecting alcohol into the oval window would be facilitated by the transtympanic approach.

Because of Lempert's reports that successful fenestration abolishes tinnitus in otosclerosis, the author believes that intolerable tinnitus should be considered an indication for fenestration of the labyrinth.

**Popper, O** Fenestration. Transtympanic Approach, *South African M J* 20 134-137 (March 23) 1946

This is an abbreviated version of the article in the *Journal of Laryngology and Otology* just reviewed.

**Popper, O** Fenestration for Otosclerosis, Correspondence, *South African M J* 20 286 (May 25) 1946

The author defends his transtympanic approach against Drs Campbell, de Villiers and Kerr. He emphasizes that he made no claims

whatsoever for fenestration. He only described a new approach by which the fenestration can be done without destroying the mastoid process.

**Portmann, G.** The Treatment of Progressive Loss of Hearing by the Fenestration Operation of Lempert, *Presse méd* 54: 301-302 (May 11) 1946

The author describes Sourdille's technic and Lempert's fenestra nov-ovalis technic in which a platinum-iridium frame is inserted into the window.

**Schenck, H. P.** Thyroxin Therapy in Otosclerosis, *Arch Otolaryng* 44: 43-50 (July) 1946

Thyroxin introduced into the middle ear cavities in 64 persons with clinical manifestations of otosclerosis failed to affect the hearing to an extent beyond the normal variations experienced in otosclerosis.

**Shambaugh, G. E., Jr.** The Fenestration Operation for Otosclerosis, *J A M A* 130: 999-1006 (April 13) 1946

The author undertook experimental and clinical investigations in order to determine as far as possible the permanence of the artificial fistula created in the labyrinth by the fenestration operation as it is now done.

Fenestrations were performed on monkeys, according to the fenestra nov-ovalis technic, with use of the irrigating apparatus and the microscope.

By killing the animals at different intervals and examining the ears microscopically one is able to construct what occurs in the human ear after the fenestration operation.

Osteogenesis which tends to close the fistula is governed by the following factors:

- 1 The sluggish response made by the enchondral layer of the labyrinthine capsule to trauma
- 2 The inhibition of osteogenesis exercised by stratified squamous epithelium
- 3 The stimulation of osteogenesis caused by presence of bone dust and fragments
- 4 The osteogenetic reaction of traumatized endosteum
- 5 The inhibiting effect of a smooth polished bone surface
- 6 The tendency of the intact membranous labyrinth that has become closely adherent to the skin flap to hold the mouth of the fistula open

By attention to all of these factors it has been possible for the first time to make a labyrinthine fistula in an experimental animal which would remain open for more than a year. With this technic the closures in the human ears have been reduced to less than 5 per cent after two years.

Clinical analysis of the results obtained in 930 consecutive fenestrations over seven and one-half years indicates that osteogenesis tending to close the fistula is, as a rule, no longer active two years after operation, 82 per cent of the fistulas closed within one year after operation and only 1 of 53 after a period longer than two years. The two year hearing result of the fenestration operation may be regarded as the permanent result.

Perfectly normal hearing is almost never attained with the operation, though in many cases the hearing is sufficiently close to normal to be regarded as normal by the patient and his friends. The average gain of the 88 per cent of the patients who maintained their maximum improvement of hearing two years after operation (fenestra nov-ovalis technic with irrigation and use of a dissecting microscope) was 28.9 decibels. In some cases the improvement is not sufficient to be of practical value. In 5 per cent of the cases the hearing is not improved, is made worse or is entirely destroyed in the ear operated on. For this reason the poorer hearing ear should be chosen for operation.

Shambaugh, G. E., Jr., and Juers, A. L. Surgical Treatment of Otosclerosis. A Preliminary Report on an Improved Fenestration Technic, *Arch Otolaryng* 43: 549-567 (June) 1946.

The authors describe a new fenestration technic developed at Wesley Memorial Hospital and Northwestern University Medical School. They emphasize that an improvement of hearing of the fenestrated ear which has been maintained for two years after operation may be regarded as permanent.

The new technic embodies several major and a number of minor changes of technics developed elsewhere.

The major changes fall into three categories: features to decrease the frequency of bony closure, features to enhance the average decibel gain and features to lessen postoperative labyrinthitis.

The measures to prevent bony closure are:

1. The periosteal bone is removed in a large area around the fistula, since observations on the monkey showed that enchondral bone responds to trauma with new bone formation less rapidly than does periosteal bone.

2. Bone dust is instantaneously removed from the fistula with suction irrigation because bone particles and bone dust stimulate osteogenesis.

3 Trauma of the endosteum within the labyrinth is avoided because bone proliferating from the endosteal layer responds to trauma with active osteogenesis

4 Bone particles are removed from the tympanomeatal skin flap While periosteum itself probably inhibits osteogenesis, any bone particles that remain adherent to it will act to stimulate osteogenesis

5 Full advantage is taken of the osteogenesis-inhibiting effect of squamous epithelium, first, by thinning the thickened outer portion of the skin flap, and second, by making the fistula at the top of a rounded mound rather than on the surface of a plain or at the bottom of a depression, so that the skin clings ever more closely to the margins of the fistula as healing and contraction proceed The very thin skin from the anterior meatal wall is swung around to cover as much of the fistula as possible

After a successful fenestration the patient hears largely by means of sound vibrations carried by the tympanic membrane to the labyrinthine fistula The following measures to enhance the mobility between the tympanic membrane and the fistula have been incorporated in the new technic The fistula is placed laterally, nearer to the facial nerve, the tympanomeatal skin flap is placed under tension, and the mucosa covering the bony horizontal semicircular canal is preserved

In order to lessen postoperative serous labyrinthitis an attempt is made to minimize the inflammatory reaction of the skin flap, which is done by using sea sponge packing, and to prevent the blood cells and serum from gravitating to the cochlea For this purpose the patient is prevented from lying on the untreated ear, because then the cochlea of the treated ear would be dependent to the fistula This is achieved by the use of a head frame which keeps the patient lying on his back or on the treated ear

**Shambaugh, G. E., Jr** Preliminary Results with a New Fenestration Technique, *Illinois M J* 90 264-268 (Nov ) 1946

This article is similar in substance to that by Shambaugh and Juers (*Arch Otolaryng* 43: 549-567 [June] 1946), just reviewed

When the factors that were found experimentally to influence the osteogenesis which tends to close the fistula were applied to the operation as performed on the human subject, the incidence of failure due to bony closure was reduced to 5 per cent in cases tested after two years

Postoperative serous labyrinthitis has been the most frequent cause of failure since the measures to prevent bony closure were adopted Blood and serum that escape into the labyrinth from the skin flap appear to be the chief cause of this labyrinthitis The sea sponge and head frame technic of preventing labyrinthitis has resulted in a striking

improvement of the early hearing results and may be expected to improve the permanent hearing results

The new fenestration technic developed at Wesley Hospital and Northwestern University embodies a number of changes from other technics, the most important ones are enchondralization of the fistula, constant irrigation of the field and use of the microscope while making the fistula, scrupulous avoidance of traumatization of the endosteum of the labyrinth, use of sea sponge packing and a head frame to prevent postoperative serous labyrinthitis

**Shambaugh, G E, Jr** Results of the Fenestration Operation for the Surgical Treatment of Deafness, *Kansas City M J* 22: 18-21 (March-April) 1946

This is a general review of the problem At the present time the percentage of failures due to bony closure is 5 per cent In 86 per cent of the cases a significant improvement of hearing is permanently maintained

**Shambaugh, G E, Jr** Factors Influencing Osteogenesis Following the Fenestration Operation Observations on the Monkey, *Arch Otolaryng* 44: 644 (Nov) 1946

These factors were presented in an article published in *The Journal of the American Medical Association* (130: 999 [April 13] 1946), reviewed in the foregoing pages

**Walsh, T E, and Silverman, S R** Diagnosis and Evaluation of Fenestration, *Laryngoscope* 56: 536-555 (Sept) 1946

The examination of the patient takes approximately six hours and is performed on two successive mornings On the first morning a pure tone audiogram of both air and bone conduction is made, followed by certain speech tests of both ears in the free field On the second morning the pure tone audiometric examination is repeated and other speech tests are given "If the patient wears a hearing aid he is tested in the free field with the volume control of the aid set at maximum usable gain setting"

The speech tests were those developed in the Psycho-Acoustic Laboratory, Harvard University The authors used test 9, consisting of "six spondaic words given to the patient through an earphone, beginning at an appropriate intensity so that he hears all six words, and then the groups are attenuated in four db steps Threshold is the level at which he hears 3, or 50 per cent, of the words" In addition test 12 was used, consisting of four sentences at each level, given as in test 9

Finally the P B test<sup>3</sup> was employed. It consists of fifty phonetically balanced words given "at levels progressively attenuated in any desired step interval. Threshold is represented by the point at which the patient hears 50 per cent of the words."

Concerning selection of patients, the authors state that one should not adhere too rigidly to the classic criteria of cases suitable for fenestration.

Some of our most successful results were in patients over fifty years of age.

It has been assumed that loss of hearing by bone conduction indicates cochlear damage. This is not necessarily so. Variables in the thickness of the cortex, the pneumatization and the thickness of the trabeculae in the mastoid together with the variation in thickness of the subcutaneous tissues must influence the conduction of sound to the cochlea from a source placed on the bone behind the ear. It is evident that a prognosis based on the bone conduction curve would be erroneous.

However, *not all* patients with a high tone loss by bone conduction should be considered suitable for fenestration.

The authors pay little attention to the bone conduction test "except from the point of view of general screening of patients."

An important clinical criterion is the fact that the otosclerotic person speaks in a "still, small voice" and articulates normally. The patient with a nerve loss has a poorly modulated loud voice and frequently slurs the consonants *s* and *th*. The authors describe a method of selecting cases suitable for operation. Without specifically mentioning the work carried out by Fowler Sr, they base their test on the fact that otosclerosis does not show recruitment of loudness, whereas nerve deafness shows recruitment.

With a special apparatus, they "deliver to the patient speech at high intensity levels relatively free from distortion. If the patient's articulation score increases proportionately with intensity, then that patient has adequate cochlear function and is suitable for the operation." If "increasing the intensity does not proportionately elevate the articulation score after a certain maximum has been reached, . . . adequate cochlear function is not present," and fenestration is contraindicated. "The suggested diagnostic procedure does not detect nerve deafness above 3500 cps, but this area is of little practical significance for the purposes of the test."

Pure tone audiometry as the sole criterion for evaluation of the results of the fenestration operation "is open to serious objection." The authors agree with the now accepted opinion that "thresholds for pure tones are not always adequate for gauging auditory function above threshold." Furthermore

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<sup>3</sup> The tests (nos 9 and 12 and P B) are described in Articulation Testing Methods II O S R D Report no 3802, Nov 1, 1944



postoperative pure tone audiometry neglects the change in the size and shape of the external transmission pathway which results from varying degrees of exenteration of bone cells. This fact may account for the discrepancy between postoperative pure tone audiometric results and observed social responses of many fenestrated patients.

The basic aim of fenestration surgery is "restoration of the patient to social adequacy in a dynamic acoustic environment." The question whether the patient has achieved social adequacy or not is determined by his postoperative "articulation score or index." The articulation score at 20, 35 and 50 decibels (i. e., the percentage of test words understood at these frequencies) is determined and then divided by 3. If the resulting figure is 50 or more, the patient has been socially rehabilitated. If the figure is less than 50, he has not been rehabilitated, no matter how great the gain was.

Williams, H. L. Selection of Patients for the Fenestration Operation for Otosclerosis, *S Clin North America* 26. 876-889 (Aug.) 1946

Williams discusses the probability of a successful result as follows:

If in a given case the bone conduction by fork testing is prolonged ten to fifteen seconds or more beyond the air conduction in the 1024 d v frequency, and the audiometric curve does not show evidence of cochlear atrophy and there is no visible evidence of deposit of scar tissue in the tympanic membrane and a presumptive diagnosis of clinical otosclerosis can be made, the probability of such a patient getting an initial restoration of the hearing to a level at which he is under no handicap in hearing normal conversation is about 70 per cent of cases in which operation is performed. This constitutes the so-called selected group. It should be remembered that about 10 to 15 per cent of those securing an initial good result will experience closure of the fenestra sooner or later.

If in a given case a presumptive diagnosis of clinical otosclerosis is made and the patient meets all criteria for the selected group except that evidences of scarring are present in the drum of the ear to be operated on, the probability of securing an initial good result may be estimated at 60 per cent.

If in a case of clinical otosclerosis evidence of cochlear degeneration is found but this does not appear to involve the speech range and the loss of hearing nowhere falls below the 50 decibel line, a 50 per cent probability of a good result may be fairly estimated if no other unfavorable conditions are present. [However] when evidences of nerve degeneration are present the probability of a reactive labyrinthitis resulting in severe loss of hearing as the result of operation is increased.

If in a case of clinical otosclerosis degeneration of the cochlea above the speech range seems apparent and the hearing curve is down to the 60 decibel level or below, a 30 per cent probability of an initial good result may be estimated.

If evidence of nerve degeneration appears to involve any of the frequencies in the speech range, no more than a 15 per cent probability of a good initial result should be offered.

There would seem to be little or no justification for operating if the otosclerosis is unilateral.

The author quotes Holmgren as saying that "even an unsuccessful operation tends to stop the progress of the pathologic process in the ear operated on."

Williams, H. L. The Fenestration Operation for the Restoration of Hearing to Conversational Levels in Loss of Hearing Due to Clinical Otosclerosis, *Proc Staff Meet, Mayo Clin* 21: 320-325 (Aug 21) 1946, *J Rehabilitation* 12: 9-13 (Dec) 1946

This is a general review of the problem. An attempt is made to promote a better understanding of the purpose and the results of the operation by answering the usual questions that are asked by both physicians and the laity.

Wojniak, F. The External Ear and Drum Membrane in Otosclerosis, *Arch. Otolaryng* 44: 249-251 (Aug) 1946

A careful comparative study of the external auditory meatus and the tympanic membrane was carried out in 100 patients with otosclerosis and 100 controls.

Atrophy of the skin of the meatus and abnormal or unusual thinness of the drum membrane appear to be more frequent in persons who are deaf than in persons with normal hearing but no more frequent in otosclerosis than in other forms of deafness. Except for Schwartz's sign, which is present twice as often in patients with otosclerosis as in patients with other forms of deafness, and five times as often in patients with otosclerosis as in persons with normal hearing, and the apparent absence of mobility of the handle of the malleus in a greater proportion of persons with otosclerosis than of the controls, there is nothing characteristic in the external ear and the drum membrane to help in differentiating otosclerosis from other forms of deafness. There even appeared to be no relation between the amount of cerumen and deafness.

Wojniak, F. The External Ear and Drum Membrane in Otosclerosis, *Ann Otol, Rhin & Laryng* 55: 406-422 (June) 1946

A study of 100 cases of otosclerosis and 100 controls is reported. In 70 cases the disease was unilateral and in 30 it was complicated by other forms of deafness.

In patients with otosclerosis the external auditory canal is generally larger than that of normal hearing subjects but corresponds closely with that of patients suffering from other forms of deafness. The amount of cerumen appears to be the same in cases of otosclerosis, normal hearing or impaired hearing from other causes. The skin of the external canal appears to be atrophic as often as it appears to be normal in patients with defective hearing, regardless of the type of deafness. Only 12.8 per cent of the normal hearing patients show signs of atrophy. The sensitivity of the skin, or the so-called "tickling reflex," shows no appreciable variations. The cough reflex appears to be of no diagnostic significance.

The drum membrane appears to be thinned out abnormally only slightly more frequently in otosclerosis than in other forms of deafness. There is no marked variation in the vascular reflex, one could say, however, that in normal hearing subjects this sign is more readily elicited. Schwartze's sign appears to be highly suggestive of otosclerosis, being present in 21 per cent of the patients with that disease. However, it was present in 10 per cent of those with other forms of deafness and in 4.2 per cent of the normal hearing patients. Mobility of the handle of the malleus appears to be absent in 47 per cent of the patients with otosclerosis, compared with 23.3 per cent of those with other forms of deafness and 14.2 per cent of those with normal hearing. The difference in the mobility of the pars tensa between the three groups studied is negligible.

Worral, J. D. Surgical Treatment of Deafness, *McGiegor Clin Bull*  
7:11 (Dec ) 1946

# Case Reports

## SOLITARY NEUROFIBROMA OF THE SUBMAXILLARY REGION

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AND

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IN 1908 VEROYAY<sup>1</sup> first described the histologic appearance of a highly differentiated tumor which resembled the nerve sheath within which it was commonly found, and in 1910 he gave the term "neurinoma" to this type of tumor. A review of the literature reveals such names applied to this tumor as "neuroma," "neurinoma," "palisading neurinoma," "neurofibroma," "solitary neurofibroma," "perineurial fibroblastoma," "fibroma of nerves," "peripheral glioma," "schwannoma," "gliofibroblastoma" and "lemmoma." This variation in terminology is evidence of the confusion which has existed because of uncertainty as to the origin of tumors of this type.

There are two main trends of thought regarding the origin of these tumors. The branching, anastomosing processes resembling connective tissue, which give rise to fibrils and collagen and are a specific product of the fibroblasts, have suggested to Penfield<sup>2</sup> that these tumors originate from the perineurial fibroblasts and are therefore mesodermal in origin. The early works of Bard, Durante, Francini, Verocay and Antoni<sup>3</sup> favor the ectodermal hypothesis. Nageotte and Masson<sup>4</sup> thoroughly studied this type of tumor and reproduced it experimentally, proving conclusively the schwannian or neurectodermal hypothesis.

Thus, such a tumor may occur in connection with any peripheral nerve or nerve root, more frequently the latter. Of the cranial nerves, the eighth is most frequently affected. The spinal nerve roots, more so the posterior roots, and the sympathetic nerves are frequently involved.

The tumor is most frequently round or oval, and may be smooth or nodular. It is usually well encapsulated, but in some cases may be infiltrative. It may be quite firm and solid in consistency or, on the other hand, soft and fluctuant.

Although the gross appearance may show wide variations, the microscopic aspect remains the same. Antoni<sup>1</sup> described two types of tissue seen microscopically. Both types are present in the tumor in varying amounts. Type A presents an orderly appearance of long slender fibers with silver-staining properties, similar to connective tissue. These fibers may be straight or serpentine, passing between the cells. The nuclei of the cells are elongated, with blunt ends, and the elongated branching and anastomosing cells form a syncytium. A most characteristic feature of tissue of this type is a palisading of the nuclei produced by an orderly parallel arrangement of the cell nuclei. Some areas resemble the struc-

<sup>1</sup> Cited by Stout<sup>5</sup>

<sup>2</sup> Penfield, W. The Encapsulated Tumors of the Nervous System. Meningeal Fibroblastoma, Perineurial Fibroblastoma and the Neurofibromata of von Recklinghausen, Surg, Gynec & Obst 45 178-188 (Aug) 1927

<sup>3</sup> Cited by Masson<sup>4</sup>

<sup>4</sup> Masson, P. Experimental and Spontaneous Schwannomas (Peripheral Gliomas), Am J Path 8 367-388 and 389-416 (July) 1932

ture of the Wagner-Meissner tactile corpuscles Type A tissue, although occasionally becoming necrotic, with resulting loss of cells, may still retain its fibrillar structure

Type B tissue is quite different in appearance No orientation of cells is present The cells and fibers are haphazardly arranged, and microcystic degeneration may be present The fibers are of the reticulin type present in type A tissue Collagen bands are rare Masson<sup>4</sup> agrees with Antoni that type B tissue represents a degenerative phenomenon, a jellification of type A tissue Blood pigment and large vacuolated phagocytes, so-called foam cells, are also considered characteristic findings in this type of tumor

The symptoms of such tumors usually result from the presence of the mass and depend on its location and the nerve trunk involved Intracranial or spinal tumors present problems to the neurologist and the neurosurgeon Stout<sup>5</sup> reported 50 cases Pain was present in only 13, and in 19 cases the mass was tender Sensory disturbance and paresthesia over the distribution of the nerve may be noted

Figi<sup>6</sup> stated in 1933 that several cases of solitary neurofibroma arising in the submaxillary region had been seen at the Mayo Clinic Stout reported that 10 cases of neurofibroma of the sublingual area had been recorded, to which he added 2 more Coates,<sup>7</sup> in 1941, reported a case involving the sublingual area

We have recently observed a case of solitary neurofibroma of the submaxillary region which we believe is worthy of reporting because of the rarity of a tumor of this type occurring in this location

#### REPORT OF A CASE

A 63 year old woman was seen in my office on Oct 12, 1945 She offered a history of pain that had been present at the base of the tongue on the right side for the past three months Examination revealed a firm encapsulated mass, elliptic in shape, measuring approximately 2 by 3 cm, and somewhat nodular, in the right submaxillary region close to the mucous membrane of the floor of the mouth Clear fluid of normal viscosity was expressed from Wharton's duct The remainder of the examination of the ears, nose and throat gave essentially negative results General examination revealed nothing of significance

On October 29, with the patient under combined local and intravenous "pentothal sodium" anesthesia, the tumor was removed through an external approach An incision 4 cm long was made in the submaxillary area, paralleling the horizontal ramus of the lower mandible By blunt dissection, the submaxillary gland was exposed and retracted laterally, bringing into view the tumor The assistant's finger was inserted into the mouth, to force the tumor mass into the submaxillary triangle, from which, by blunt dissection, it was delivered *in toto* A Penrose cigaret drain was placed in the wound, and the incision was closed with subcutaneous catgut and 00000 "zytor"

The specimen consisted of an encapsulated mass, 2 by 3 cm in diameter, of uniform firm consistency except for small central areas of softening

Microscopic examination of routine hematoxylin-eosin preparations revealed an encapsulated neoplasm consisting of interlacing bundles of spindle shape cells which in some areas showed a tendency toward palisading In the central portions

5 Stout, A P The Peripheral Manifestations of the Specific Nerve Sheath Tumor (Neurilemma), *Am J Cancer* **24** 751-796 (Aug) 1935

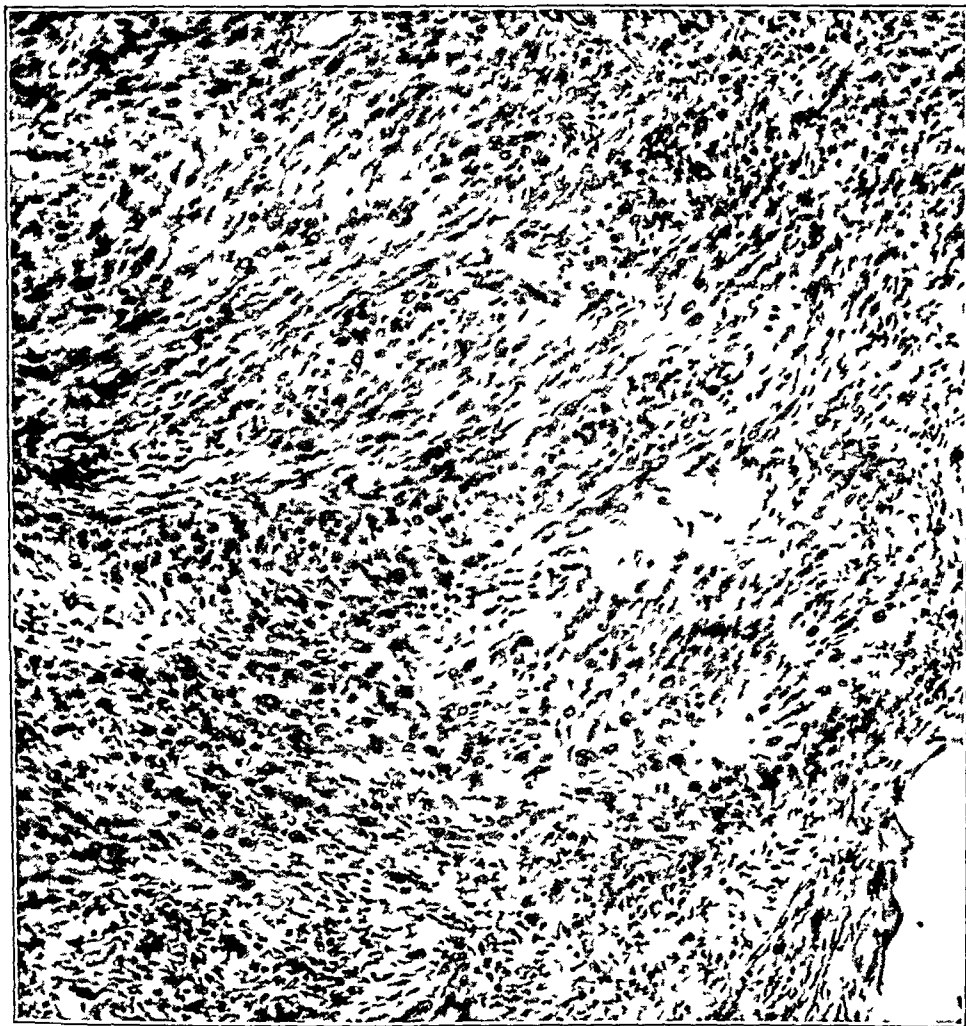
6 Figi, F A Solitary Neurofibroma of the Pharynx, *Arch Otolaryng* **17** 386-389 (March) 1933

7 Coates, G M Schwannoma of the Mouth, *Arch Otolaryng* **34** 1166-1167 (Dec) 1941

of the neoplasm there were areas of edema and a few pigment-laden macrophages which were present as the result of old trauma, circulatory disturbance and hemorrhage (figure)

The patient made an uneventful recovery. Postoperative examination revealed complete loss of sensation over the whole right side of the tongue. One year after removal of the tumor examination revealed no evidence of recurrence. The numbness on the right side of the tongue was still present.

Preoperatively the patient appeared to have a mixed tumor of the submaxillary gland. Following microscopic studies of the removed tumor, closer questioning



Photomicrograph of solitary neurofibroma of the submaxillary region,  $\times 160$

revealed that the patient had been noting gradual progressive loss of sensation over the whole right side of the tongue for the past year.

#### COMMENT

A case of solitary neurofibroma of the submaxillary area is presented. Such a tumor located in this area is rarely diagnosed preoperatively as neurinoma or neurofibroma, but is most frequently diagnosed as being a mixed tumor. However, sensory or motor changes should lead one to suspect a tumor of nerve origin.

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# New Instruments and Technics

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## TREATMENT OF OTITIS EXTERNA WITH SULFANILAMIDE OINTMENT

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WHILE stationed with the Armed Forces in India, I had occasion to treat a large number of infected external auditory canals. That country was extremely hot, humid and dusty, which increased the severity and the prevalence of all infections of the skin and made their control of major importance and at the same time more difficult of achievement. After all the usual methods of treatment had been tried, with disappointing results, a new method was found which yielded the quickest and most lasting results. This consisted in scrupulous cleansing of the canal with cotton-tipped applicators dipped in hydrogen peroxide, then thorough drying of the canal with cotton applicators and liberal application of 5 per cent sulfanilamide ointment, all surfaces of the canal and drum being covered with this. Pain, which was commonly present, generally subsided after the first treatment. In nearly all cases, itching and all signs of irritation were cured by daily treatments continued for a period of seven to twelve days, a few patients required longer treatment of three to four weeks with gradually lengthened intervals between visits. A small percentage of patients showed a recurrence, this responded to reinstitution of the local treatment. Some patients presented the appearance of severe cellulitis and edema of the canal with only a filiform opening in the canal or no opening at all. These patients were hospitalized and given full doses of sulfonamide compounds or penicillin and moist heat locally until the cellulitis subsided, then they were discharged and followed in the clinic. Occasionally an external canal would appear to be perfectly well after treatment, yet the patient would complain of itching, in cases of this type, wiping of the canals with an applicator soaked in meta-cresylacetate resulted, after two or three applications, in cessation of the itching.

This method of treatment was found to be beneficial in cases of mold infection as well as in those due to fungi and bacteria. The ointment containing sulfanilamide in concentration of 5 per cent was chosen empirically, later it was discovered that Senturia and Wolf<sup>1</sup> had reported that, of all sulfonamide compounds, only sulfanilamide had fungistatic effects on surface colonies of *Aspergillus*, *Penicillium* and *Mucor* besides the ordinary bacteriostatic power of the other sulfonamide compounds.

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From the Massachusetts Memorial Hospitals

1 Senturia, B. H., and Wolf, F. T. Treatment of External Otitis. II. Action of Sulfanilamide on Fungi Isolated from Cases of Otomycosis, *Arch Otolaryng* 41:56 (Jan.) 1945

# Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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## PERORAL ENDOSCOPY

A Review of the Literature for 1946

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AND

JAMES T. SPENCER, Jr., M.D.

PHILADELPHIA

AND

CAPTAIN C. D. RIGGS (MC), U. S. N.

### CONGENITAL ANOMALIES OF THE TRACHEOBRONCHIAL TREE

CONGENITAL anomalies of the tracheobronchial tree unquestionably are more common than medical literature would indicate. Many cases terminate fatally before studies can be instituted, and never are recognized unless necropsy studies are permitted. In addition, certain congenital anomalies produce minimal clinical signs and symptoms and often are not detected. Where the roentgenogram and the bronchoscope are employed more frequently in the diagnosis of bronchopulmonary disorders, anomalies of the latter group are recognized.

*Pulmonary Anomaly*—Field<sup>1</sup> reported a series of 14 cases of pulmonary anomalies which were grouped as follows: 5 cases of absence or permanent underdevelopment of one lung, 1 case of agenesis, aplasia or permanent hypoplasia, 6 cases of displacement of the heart and mediastinum with slow readjustment, probably a temporary hypoplasia, and 3 cases in which a localized opacity was shown on the roentgen film. The last-mentioned cases were interpreted as instances of hypoplasia or of atelectasis of part of a lung with no bronchial communication. In a number of these cases bronchoscopy and bronchography were performed for corroboration of the diagnosis.

Mitchell<sup>2</sup> reported the following cases:

A child 2 years of age with an undiagnosed lesion of the right side of the chest became dyspneic and cyanotic immediately on aspirating some partially masticated peanuts and some chewing gum into the tracheobronchial tree. Cyanosis and dyspnea persisted, and the child died within twenty minutes after aspiration.

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1 Field, C. E. Pulmonary Agenesis and Hypoplasia, Arch Dis Childhood 21:61 (June) 1946.

2 Mitchell, H. E. Agenesis of the Right Lung with Death Following Aspiration of Foreign Bodies into the Left Lung, Ann Otol, Rhin & Laryng 55:609 (Sept.) 1946.



of the foreign bodies, so that no bronchoscopic or other procedure could be carried out

At autopsy the right lung was completely absent, and there was a bronchus ending blindly. There was neither rudimentary right lung tissue nor vessels. When the left bronchus was opened, two foreign bodies, a masticated mass of peanuts and chewing gum, were found.

A discussion of reported cases of agenesis of a lung is included in the article.

Pierson<sup>3</sup> reported a case of aplasia of the lung.

A positive diagnosis was made, following roentgen study, bronchoscopy and bronchography, when the patient was 8 months of age. The differential diagnosis of congenital absence of a lung is difficult. Pneumonia, hydrothorax, paralysis of the diaphragm, diaphragmatic hernia and foreign body lodged in a bronchus must be considered. The usual roentgen interpretation is massive or fetal atelectasis.

The bronchoscopic examination was carried out with a 35 mm bronchoscope. The trachea was deviated to the right. There was no evidence of a carina or of a right bronchus. The left bronchus was normal. Later iodized oil was introduced through a tracheal catheter without complications, and this revealed a normal left bronchus, there being no evidence of bifurcation.

At the time of the report the patient had been observed on two occasions for an acute infection of the respiratory tract, each with complete recovery. At the time that the report was made the patient was convalescing from measles.

#### TRACHEOBRONCHIAL APPLICATION OF PENICILLIN

That penicillin is of value in the treatment of bronchopulmonary suppuration is recognized, but it must be emphasized that it is an aid rather than a substitute. This applies particularly to those conditions in which drainage has to be provided through the air passages or by surgical intervention. As in the case of the sulfonamide compounds, which were generally employed and received generous acclaim for a time, so also will penicillin be tried. Pharmacologic and clinical reports indicate to date that penicillin will earn a place in the treatment of certain tracheobronchial infections.

In a discussion of this subject Andrews and Holinger<sup>4</sup> summarized the results obtained with penicillin aerosol in 40 cases of bronchopulmonary disease associated with infection. The great majority of the patients were improved. Penicillin is particularly suited for topical application because it is readily soluble in water, isotonic solution of sodium chloride and body fluid, it does not readily diffuse and its potency is not affected by organic detritus. The reduction of the amount and the improvement of the purulent bronchial secretions of bronchiectasis make the instillation of penicillin solution an important adjunct of the preoperative preparation of the patient. The decrease of the amount

3 Pierson, W. M. Aplasia of the Lung, *Ann. Otol., Rhin. & Laryng.* 55: 604 (Sept.) 1946.

4 Andrews, A. H., Jr., and Holinger, P. H. Penicillin Therapy in the Trachea and Bronchi, *Ann. Otol., Rhin. & Laryng.* 55: 617 (Sept.) 1946.

of secretion lessens the danger that this may spill over into the other lung or other lobes

Penicillin solution given in nebulized form has appeared to be more effective in some cases than penicillin solution administered intramuscularly. Avoidance of injection, self medication and home treatment are aspects of penicillin therapy deserving consideration.

Insufficient experience with prolonged treatment renders it difficult to evaluate the comparative effectiveness of penicillin aerosol in acute and in chronic bronchopulmonary disease. The incidence of reactions following the use of penicillin aerosol may be as high as 15 per cent, but reactions constituting a serious threat to patients have not been observed.

In the experience of Hanks<sup>5</sup> the best results obtained in the treatment of infections of the respiratory tract have been secured by employing a saline solution of penicillin with a strength of 500 units per cubic centimeter. He has also found that if the solution is kept in a refrigerator it will not deteriorate rapidly but will remain potent for at least four months longer. The method of nebulizing the solution is simple. A DeVilbiss atomizer, no. 40, is connected by a rubber tube to an oxygen tank with a flow meter and a humidifier, and 2 cc of penicillin is placed in the glass nebulizer. The oxygen flow is set at 4 liters. The patient is instructed to hold the nebulizer between the teeth and breathe through the mouth. The treatment usually takes twenty minutes and is given once a day. In a group of 34 patients he found that 94 per cent received appreciable benefit. In those with acute laryngitis, tonsillitis and bronchitis the results were startling. One to three treatments gave complete relief from fever. Streptococcic pneumonitis and even virus pneumonia also responded to this method of treatment, even after parenteral injection of penicillin solution had failed.

Nebulized penicillin solution was given to 43 patients who had bronchiectasis, bronchitis or asthma by Southwell.<sup>6</sup> In the bronchiectatic ones there was no improvement, and this was attributed to the poor entry of air in the region of the disease, the multiplicity of the infectious organisms and the extensive pulmonary damage.

In the cases of bronchitis of short duration the results were more encouraging. Of 6 patients treated, 5 were apparently cured and 1 was much improved. In 5 patients with chronic suppurative bronchitis there was no improvement. It would seem, therefore, that any measure that can cut short attacks of bronchitis, which exert a permanent damaging effect on bronchial epithelium with accompanying peribronchial fibrosis, would be of great importance in therapy.

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5 Hanks, R. J. Nebulized Penicillin in the Treatment of Respiratory Infections, *Dis of Chest* 12 242 (May-June) 1946

6 Southwell, N. Inhaled Penicillin in Bronchial Infections, *Lancet* 2 225 (Aug 17) 1946

In chronic bronchitis and bronchitic asthma it appears that the more dry the bronchi the greater is the degree of improvement to be expected. The possibility of combining sulfonamide therapy with inhalation of penicillin aerosol in dealing with penicillin-resistant organisms in certain of these cases was suggested.

Studies were carried out by Humphrey and Joules<sup>7</sup> to find a suitable route, dose and interval of time for penicillin treatment of chronic infection of the lungs and bronchi. The good results obtained with intramuscular injections in acute bronchopulmonary infections have been in striking contrast to the poor results obtained in chronic conditions, and it was decided to explore the possibilities of inhalation of the aerosol.

Studies of sputum made after intramuscular injections revealed that while penicillin was found in significant amounts in the majority of samples of sputum in cases of lobar pneumonia, in those of pulmonary abscess, chronic bronchitis and bronchiectasis it was only occasionally detected. Penicillin administered as a fine mist could be detected in the sputum for six hours or more after inhalation of a single dose of 15,000 units. The exact time varied with the dose inhaled.

In a study of 80 patients treated by inhalation it was found that 46 were much improved and 17 moderately improved. While in those with acute and subacute conditions which responded to treatment recovery was usually complete, those whose disease was more chronic were relieved but not permanently cured. Preoperative and postoperative treatment of patients with chronic pulmonary infections who were submitted to operation was associated with a low complication rate.

Observations made by Morse<sup>8</sup> on the use of a penicillin spray produced by a hand atomizer suggested that it is effective in various infections of the respiratory tract. The method is easy, inexpensive and quite as generally applicable as sulfonamide therapy, yet is not dangerous. While his series of cases, totaling 25, is not large, the results warrant further trial in a large number of cases. He found that penicillin spray generated by hand or bulb atomizer was effective against many infections of the respiratory tract, including those of the nasopharynx. The penicillin spray generated by an atomizer is a cheap, safe, painless agent which may be applied by home users and by untrained personnel.

In a group of 14 patients with bronchopulmonary disease treated with penicillin aerosol, Fullerton and Shane<sup>9</sup> administered 25,000 units

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7 Humphrey, J. H., and Joules, H. Penicillin Inhalation in Pulmonary Disease, *Lancet* 2:221 (Aug. 17) 1946.

8 Morse, F. W. Penicillin Spray by Bulb Atomizer in Respiratory Infections, *J. A. M. A.* 132:272 (Oct. 5) 1946.

9 Fullerton, C. W., and Shane, S. J. Treatment of Acute and Chronic Pulmonary Disease with Penicillin Aerosol, *Canad. M. A. J.* 54:535 (June) 1946.

every three hours. Lobar pneumonia responded in 4 cases, but virus pneumonia appeared to be uninfluenced. A pulmonary abscess of over four months' duration was cured after six and one half weeks of therapy, but another chronic pulmonary abscess did not respond satisfactorily, stenosis of a bronchus was discovered and this, interfering with drainage, probably also interfered with entrance of the penicillin.

In 3 patients bronchiectasis, and in 3 chronic bronchitis, of long duration in all, did not respond satisfactorily. In but a single patient was a reasonably favorable result secured. It is possible that failure to secure beneficial results was due to the presence of resistant gram-negative organisms, which were found in the sputum of 4 of the 5 other patients. It is their opinion that if favorable results are not obtained within one week, this therapy should be discontinued.

#### POSTOPERATIVE PULMONARY COMPLICATIONS

The problems of traumatic surgery of the chest in the military theater are identical with those encountered in ordinary civilian experience. Pulmonary atelectasis developing after trauma of the chest will, if unrelieved, result in pneumonitis.

Samson and Brewer<sup>10</sup> emphasized that with any degree of obstruction of a bronchus the treatment should be aimed at improving the impaired tracheobronchial drainage as rapidly as possible. Pain resulting from concussion of a thoracic wall or fracture of ribs is a common cause of inability to breathe deeply or to cough and raise sputum. Nerve block for the control of pain of the thoracic wall has been found useful, particularly when this produces limitation of respiration and cough. If simple measures are not adequate, mechanical aspiration of the content of the tracheobronchial lumen should be resorted to and either a tracheobronchial catheter or a bronchoscope may be used. Each has its advantages, and there are but two clearcut indications for the one rather than the other. Bronchoscopy may be followed by repeated catheteral aspiration, for the technic and the equipment for catheteral suction are simple and usually readily available. Since one may practice this without anesthesia, the catheter can be more easily used in an emergency. When it is probable that frequent aspirations will be necessary, catheteral suction should probably be performed from the beginning.

Bronchoscopy is a highly technical procedure and should be performed by one especially trained in this technic. Bronchoscopic aspiration is more efficient than catheteral suction, since it is done under direct vision, and all visible bronchi may be aspirated by employing straight or curved suction tubes. Bronchoscopy is the treatment of choice when

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10 Samson, P. C., and Brewer, L. A. Principles of Improving Inadequate Tracheo-Bronchial Drainage Following Trauma to the Chest, *J Thoracic Surg* 15 162 (June) 1946.

the obstruction is due to particulate material, blood clots and plugs of thick mucus. In a case of unilateral massive collapse, immediate bronchoscopic aspiration is preferable to a more conservative regimen. It is indicated in partial tracheal obstruction and also should be employed when an unconscious patient aspirates vomitus, particularly postoperatively, before he leaves the operating room. Postoperative vomiting is observed more often in military than in civilian surgical patients, and the necessity to aspirate vomitus from the tracheobronchial tree would therefore be a more frequent complication.

A majority of the postoperative pulmonary complications are directly related to tracheobronchial retention of secretions or to aspiration of foreign material. Conklin<sup>11</sup> recommended that in prevention the first consideration should be given to the preoperative condition and preparation of the patient. The presence of an acute infection of the upper respiratory tract should call for several weeks' postponement unless the indication for surgical intervention is urgent. Oral hygiene likewise calls for preoperative attention, as it has been shown that after surgical treatment fewer pulmonary infections develop in edentulous patients than in others. Dentures and teeth should be examined before and after operation, and sponges, instruments and pieces of tissue should be carefully checked when one is operating about the mouth or the throat.

The choice of preoperative medication and of anesthesia should be such as to assure early return of the cough reflex and of consciousness. With this in mind meperidine hydrochloride ("demerol hydrochloride") is preferable to morphine sulfate and scopolamine hydrobromide. Clearing the tracheobronchial tree of secretion is important, and the patient should be encouraged to cough at frequent intervals. Analgesic drugs should be used to reduce the pain due to cough but in doses small enough so that the cough reflex will not be eliminated. Secretions which cannot be got rid of by the ordinary methods must be aspirated either by employing a catheter, preferably passed nasally, or a bronchoscope if this method fails.

Pulmonary complications have been the most serious cause of postoperative morbidity. Gordon<sup>12</sup> expressed the opinion that in all cases "postoperative pneumonia" develops on a basis of unrelieved pulmonary atelectasis. The greater proportion of postoperative patients suffering from atelectasis will remove the obstructing secretions from the bronchial tree by deep breathing and forced coughing and then will reexpand the collapsed segment of lung. When this cannot be accomplished within

11 Conklin, W. S. Postoperative Pulmonary Complications. Prevention and Treatment, *Northwest Med* 45:494 (July) 1946.

12 Gordon, R. A. Bronchoscopy in the Treatment of Pulmonary Atelectasis, *Canad M A J* 54:6 (Jan) 1946.

a reasonable period, preferably a few hours, the obstruction should be removed. This may be done efficiently and with little discomfort to the patient by aspirating the secretions under direct vision through the bronchoscope.

The bronchoscope has been found useful in providing suction drainage of the tracheobronchial tree for postoperative patients, for patients who are unconscious or who are suffering from injury of the nervous mechanism controlling cough and for those who have aspirated blood or other foreign material. If aspiration is delayed, it may be found impossible to fully expand the collapsed segment of lung immediately, and the danger of a superimposed pneumonic process may be faced.

In a discussion of the surgical management of abdominal wounds, Snyder<sup>13</sup> reported that the incidence of atelectasis was higher subsequent to laparotomy than after thoracotomy although in many instances of the latter the pulmonary secretions were routinely aspirated. He believed that the number of cases in which atelectasis followed laparotomy would have been materially reduced if there had been a routine immediate postoperative catheteral or bronchoscopic aspiration of the tracheobronchial tree.

*Postanesthetic Bronchopneumonia*—In a study of the bronchopneumonia observed in 20 patients on an obstetric service, Hartzell and Mininger<sup>14</sup> concluded that the chief cause was the aspiration of vomited gastric contents. Possible contributing factors were the preanesthetic medication, favoring suppression of the cough reflex, the prolonged gastric evacuation in labor and the fluidity of the gastric contents, favoring their intrabronchial dissemination.

Anesthesia had been induced in these cases with ether, which was administered usually by the open method and was preceded by varying quantities of barbiturates and other premedication drugs.

The bronchopneumonia was discovered in almost all cases by means of roentgenograms of the chest made to investigate the significance of slight fever or bronchopulmonary physical signs following delivery. While in no instance was the pneumonia of sufficient clinical severity to require the use of chemotherapy, the employment of this did not affect the course of the disease in any case in which it was administered. Postural drainage and catheteral or bronchoscopic aspiration of the bronchial tree are recognized methods of treating patients who aspirate vomitus during anesthesia. Preoperative induced emesis when carefully executed might prevent the postanesthetic vomiting and aspiration of foreign materials.

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13 Snyder, J. M. Surgical Management of War Wounds of the Abdomen, *Am J Surg* 72:331 (Sept.) 1946.

14 Hartzell, H. C., and Mininger, E. P. Bronchopneumonia Following Ether Anesthesia in Obstetrics, *Surg, Gynec & Obst* 82:427 (Apr.) 1946.

Pulmonary complications appear more common after general anesthesia than after spinal anesthesia unless a careful prophylactic regimen is observed before, during and after operation. In a study of the incidence of postoperative atelectasis and pneumonia, Dripps and Deming<sup>15</sup> found that among 250 surgical patients the incidence was 11 per cent when inhalation, and 4.2 per cent when spinal, anesthesia had been used. After the institution of a positive prophylactic program to be carried out prior to the administration of inhalation anesthesia for any operation involving the upper part of the abdomen, they discovered that the incidence of respiratory complications following spinal anesthesia remained unchanged but that the incidence following general anesthesia was reduced to 4.1 per cent.

Among the preoperative measures was that of postponing surgical treatment, except in case of emergency, for one or two weeks when a patient had an infection of the upper respiratory tract. Patients with chronic disease of the respiratory tract were urged to cough up all secretions possible, and when this did not appear to clear the tracheobronchial tree, aspiration was done bronchoscopically.

During the operative procedure anesthesia was maintained on the lightest plane compatible with the surgical procedure. Every effort was made to prevent aspiration of secretions, particularly of regurgitated gastric contents.

During the postoperative period the patient's position was changed completely at least hourly. Secretions were aspirated from the nose and the mouth by catheter as often as necessary. The quantity of narcotic drug was limited. The patient was encouraged to cough. Carbon dioxide was given by inhalation as indicated. These authors expressed the opinion that a postanesthetic observation room staffed by trained personnel and equipped to handle all emergencies should constitute a part of all surgical services.

Investigation of the etiologic factors causing postoperative atelectasis and pneumonia revealed that the incidence was higher in men, in smokers, in persons who had undergone operations involving the upper part of the abdomen, in patients with chronic or acute infections of the respiratory tract and also with increasing age of the patient and with increasing length of operation.

Eight cases of pulmonary atelectasis observed in connection with a series of 85 operative procedures involving the upper urinary tract led Faulconer and his associates<sup>16</sup> to make a careful study of this problem. In every case the atelectasis occurred in the contralateral

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15 Dripps, R. D., and Deming, M. V. Postoperative Atelectasis and Pneumonia, *Ann Surg* **124** 94 (July) 1946.

16 Faulconer, A., Jr., Gaines, T. R., and Grove, J. S. Atelectasis During Operations on the Upper Urinary Tract, *Anesthesiology* **7** 635 (Nov.) 1946.

lung The only common possible etiologic factor was the unphysiologic lateral position required for this type of operation A wide variety of anesthetic agents and methods was used and seemed to have no important bearing on the postoperative pulmonary complications None of the patients received prophylactic carbon dioxide-oxygen hyperventilation In 6 of the cases bronchoscopic aspiration was performed as soon as the diagnosis of atelectasis was made In 3 cases it was necessary to repeat this procedure They suggested, as an important point in prophylaxis, that the patient's position be shifted to the side of operation at frequent intervals

*Mediastinal Cyst*—Preliminary to doing a tracheotomy in an infant aged 3 months who was dyspneic, Tucker<sup>17</sup> inserted a bronchoscope and found a compression of the posterior wall of the trachea producing expiratory collapse This compression extended down to the level of the bifurcation Tracheotomy was done, with temporary relief of dyspnea, later, however, dyspnea increased, and the mass appeared to be growing larger The patient died one week after being admitted to the hospital, of pulmonary complications

At postmortem examination a mediastinal cyst was found, probably arising from the trachea, which produced compression of the trachea and the left main bronchus The esophagus was displaced posteriorly No direct connection of cyst and trachea or esophagus could be demonstrated

#### TUMORS AND OTHER INVOLVEMENTS OF THE TRACHEOBRONCHIAL TREE

*Adenoma*—In a review of the literature concerning adenoma of the bronchus, Gonzalez Loza<sup>18</sup> discussed the histologic structure the histogenesis and the question of whether this tumor is malignant Two cases of bronchial adenoma are reported

One of the patients, a woman aged 48 years, complained of fever, dyspnea, pain of the right side of the chest and loss of weight of one month's duration At bronchoscopy a small tumor observed in the right inferior bronchus was readily removed with forceps

The second patient, a girl 14 years of age, had fever, night sweats, repeated hemoptysis and loss of weight Tuberculosis was suspected Roentgen examination revealed atelectasis of the lower part of the right lung At bronchoscopy a reddish tumor, which bled freely and completely blocked the bronchus, was found attached by a wide pedicle to the lateral wall of the right bronchus beyond the orifice of the upper lobe bronchus This was completely extirpated by endo-

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17 Tucker, G Congenital Cyst in the Mediastinum Producing Compression of the Lower Trachea and Esophagus, *Ann Otol, Rhin & Laryng* 55 693 (Sept) 1946

18 Gonzalez Loza, M Bronchial Adenoma, *Rev argent de bronco-esofagol* 2 58 (Jul.) 1946



scopic means There has been no recurrence during the four years following removal

*Lipoma*—Benign bronchial tumors may produce complete bronchial obstruction and often fatal suppuration of the lung tissues distal to the occlusion While their occurrence is not common, with more frequent bronchoscopy and routine roentgen studies of the chest more of the benign tumors are being diagnosed clinically Watts<sup>19</sup> and his associates reported a case of lipoma of the bronchus, the literature was reviewed, and the occurrence of fatty tumors of the lung was discussed

In the case reported, a diagnosis of tuberculosis had been made, and the patient was treated in a sanitarium for one year, with some improvement, although cough, fever and night sweats continued unabated The sputum was repeatedly negative for tubercle bacilli when examined by the writers, roentgenograms revealed a granular process involving the upper lobe of the left lung Bronchograms were made, but the upper lobe could not be visualized At bronchoscopy, purulent secretion was found bilaterally, but no obstructing lesion could be seen Since no definite diagnosis could be made and stenosis of the upper lobe bronchus of the left lung appeared to be present, an exploratory thoracotomy was performed The upper lobe of the left lung was found atelectatic It was decided, therefore, to perform lobectomy, and the upper lobe was removed The patient's postoperative course was uneventful, and he was discharged from the hospital fourteen days postoperatively

Pathologic study revealed an encapsulated tumor 2 cm in diameter in the main bronchus of the upper lobe of the left lung, attached by a narrow pedicle and completely occluding the lumen A diagnosis of lipoma was made

*Bronchogenic Carcinoma*—In 100 consecutive cases of primary pulmonary carcinoma examined by Lindskog<sup>20</sup> 65 patients were found inoperable when first admitted Three refused treatment Surgical exploration was performed on 32 patients, and in 20 of these the tumors were not found suitable for resection Of the 12 patients whose tumors were resectable, 10 were treated by pneumonectomy, and in 2 lobectomy was performed At the time of report 3 patients had survived 2.5 to 5.5 years after successful resection of their tumors

It was of interest to note that the upper lobes, together with the stem bronchi above the orifices of the upper lobe bronchi, were involved in 69 per cent of cases Tissue yielding a positive diagnosis was obtained from 82 patients, from 77 during life and from 5 at autopsy, but of these only 28 had revealed positive evidence of carcinoma at bronchoscopy In 20 of the 32 cases in which exploration was done, the operation was approached without a positive biopsy and with only

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19 Watts, C. F., Claggett, O. T., and McDonald, J. P. Lipoma of the Bronchus. Report of a Case, *J Thoracic Surg* **15** 132 (April) 1946

20 Lindskog, G. E. Bronchogenic Carcinoma, *Ann Surg* **124** 667 (Oct) 1946

a presumptive clinical diagnosis. In 10 of the 12 resections this also proved to be the case.

In a series of 448 cases proved to be instances of carcinoma of the lung, reviewed by Claggett,<sup>21</sup> there was revealed in 70 to 75 per cent a lesion occurring in a bronchus accessible to bronchoscopic examination and biopsy. Claggett stated that bronchoscopy is a valuable diagnostic aid and that it should be carried out in every case in which the possibility of carcinoma of the lung is suggested. It not only furnished accurate information about the pathologic nature of the bronchial lesion but also was of value in determining the exact site of the lesion and thus providing important information regarding the operability. In at least 25 to 30 per cent of the cases the lesion was not accessible to bronchoscopic biopsy, and in these, therefore, the carcinoma would have become inoperable if positive proof of the diagnosis had been demanded before the patient was accepted for operation. He emphasized the importance of exploratory thoracotomy.

In spite of improvements of diagnosis and of surgical treatment, the death rate from carcinoma of the lung remains appallingly high. The two most important factors responsible are delay on the part of the patient in consulting a physician and delay on the part of the physician in arriving at a correct diagnosis. While bronchoscopy is undoubtedly the best single procedure for diagnosing lesions of the trachea and larger bronchi, it is of little positive value in the diagnosis of the peripherally situated tumors. On the basis of the literature concerning the operability of bronchogenic carcinoma it appears that in the cases in which the carcinoma can be diagnosed bronchoscopically it is more often inoperable while in those in which it is beyond the range of bronchoscopic vision it more often can be successfully resected.

Herbut and Clerf<sup>22</sup> studied bronchial secretions removed bronchoscopically and on the basis of their findings concluded that carcinoma can be positively diagnosed in an additional number of cases over and above the number in which it is diagnosed by biopsy. In 30 consecutive cases of primary pulmonary carcinoma the bronchial secretions were stained by the Papanicolaou technic and cancer cells were demonstrated in 22, or 73 per cent. In the same series a positive bronchoscopic biopsy specimen was secured in 11 cases, or 36 per cent. The cytologic method is not presented as a substitute but as an aid to the means already employed in the diagnosis of pulmonary carcinoma. It is particularly useful in those cases in which the tumor is located at the periphery of the lung or in an upper lobe beyond the range of bronchoscopic vision.

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21 Claggett, O. T. Tumors of the Lung, *South M J* **39** 138 (Feb.) 1946.

22 Herbut, P. A., and Clerf, L. H. Bronchogenic Carcinoma Diagnosis by Cytologic Study of Bronchoscopically Removed Secretions, *J A M A* **130** 1006 (April 13) 1946.

Further cytologic studies of bronchial carcinoma made by Clerf and Herbut<sup>23</sup> corroborated their earlier view, namely, that this method affords additional aid in the diagnosis of carcinoma in those cases in which the bronchus cannot be visualized bronchoscopically. In a group of 57 cases proved to be instances of bronchogenic carcinoma, the cytologic diagnosis was made in 47 cases (82.4 per cent). A diagnosis was made by bronchoscopic biopsy in 24 cases (42.1 per cent) and by anatomicopathologic changes in 15 cases (26.3 per cent), a total of 39 bronchoscopic diagnoses (68.4 per cent). While the difference between the percentage rates—82.4 for the cytologic diagnosis and 68.4 for the bronchoscopic diagnosis—is impressive, of more importance is the group in which bronchoscopy gave a negative, and cytologic examination a positive, diagnosis. In all of the latter the diagnosis was corroborated either at surgical exploration or at autopsy. It is believed that when more frequent roentgen examinations are made, and all patients whose roentgenograms show questionable shadows are subjected to bronchoscopy, so that secretions may be secured for cytologic study, the diagnosis of bronchogenic carcinoma will be made earlier, more patients will be found suitable for surgical treatment and the prognosis of bronchogenic carcinoma will become more hopeful.

*Cystic Disease of Lungs*—In a report based on a study of 22 cases of cystic disease of the lung, Dickson and his associates<sup>24</sup> emphasized the protean nature of the symptoms, which are dependent largely on the size of the cyst, its location and the presence or the absence of a bronchial communication. While an accurate diagnosis is largely dependent on adequate roentgenologic examination of the thorax, bronchoscopy has definite value, particularly if the patient is to be treated surgically, to rule out the possibility of other bronchial lesions. Occasionally an accurate diagnosis can be arrived at only by exploratory thoracotomy.

*Boeck's Sarcoid*—The cause of Boeck's sarcoid, a chronic systemic disease which resembles tuberculosis, leprosy and other members of the granuloma family, is unknown. The disease is as protean in its manifestations as are tuberculosis and syphilis. The diagnosis usually is based on the correlation of the histopathologic picture and the clinical syndrome. Microscopic examination of tissue obtained for biopsy or at postmortem examination has been the basis for the diagnosis in most of the reported cases.

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23 Clerf, L. H., and Herbut, P. Diagnosis of Bronchogenic Carcinoma by Examination of Bronchial Secretion, *Ann Otol, Rhin & Laryng* 55:646 (Sept.) 1946.

24 Dickson, J. A., Claggett, O. T., and McDonald, J. R. Cystic Disease of the Lungs and Its Relationship to Bronchiectatic Cavities. A Study of Twenty-Two Cases, *J Thoracic Surg* 15:196 (June) 1946.

In the case reported by Olsen<sup>25</sup> the diagnosis was made by way of bronchoscopic examination and biopsy. The mucosa of the lateral wall of the right main bronchus had an unusual nodular appearance. The pathologist made a diagnosis of chronic granuloma resembling tuberculosis. The patient, a 47 year old woman, complained of difficulty in swallowing and talking and huskiness of voice. There was found paralysis of the right side of the larynx, the right constrictor muscles of the pharynx and the right side of the soft palate. Routine laboratory tests were negative. Roentgen studies of the lungs revealed changes in the upper field of the right lung, suggesting pulmonary tuberculosis.

Boeck's sarcoid is a condition which must be kept constantly in mind by those interested in thoracic disease and bronchoscopy. Although this condition is most commonly confused with pulmonary tuberculosis and Hodgkin's disease, it also must be distinguished from primary or metastatic cancer of the lung, leukemia, pulmonary fibrosis, bronchiectasis and fungous disease of the lung.

*Atrophic Tracheobronchitis*—Cases of marked localized keratosis unassociated with atrophic changes of the mucosa of the air passages have been reported. The case of atrophic tracheobronchitis with metaplasia reported by Brethauer and Culleton<sup>26</sup> is unique in that a careful search of American literature has revealed no other report of a combination of all the lesions described. In their case there was long-standing rhinitis with ozena and the typical gross findings of atrophic laryngo-tracheobronchitis. In addition there was microscopic evidence of metaplasia of the epithelium with areas of ulceration, marked keratosis, hyperplasia of mucous glands, hypertrophy of the smooth muscle, increased connective tissue with chronic inflammation, submucosal and areas of new bone formation degeneration of the cartilage.

The patient, a man aged 40 years, gave a history of chronic rhinitis with crust formation and fetid odor of ten to twelve years' standing. He was admitted because of severe almost intractable dyspnea, orthopnea and paroxysmal productive cough. Grossly there were crusts in the nose, the larynx and the trachea, and it was necessary to remove the latter with forceps. Symptoms soon recurred and became progressively worse. The patient ultimately died twenty-four hours after the onset of severe dyspnea, which could not be relieved. The tracheal wall was found markedly thickened, and immediately below the thyroid cartilage the lumen was only 10 mm in diameter. On section the epithelium here was entirely of a stratified squamous variety with marked keratinization.

A case of cicatricial stenosis of the trachea occurring in a boy who fourteen years previously had diphtheria requiring intubation was

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25 Olsen, A. M. Boeck's Sarcoid. A Brief Review and Report of a Case in Which Diagnosis Was Made By Bronchoscopic Examination and Biopsy, *Ann Otol, Rhin & Laryng* 55 629 (Sept) 1946.

26 Brethauer, E. A., Jr, and Culleton, J. F. A Case of Atrophic Tracheobronchitis with Metaplasia, *Ann Int Med* 24 505 (March) 1946.

reported by the Bences<sup>27</sup> The dyspnea due to retention of secretions was alarming A clinical diagnosis of tracheal stenosis was corroborated by roentgen study and endoscopic examination A fibrous stricture, 4 by 5 mm, was found at the level of the second tracheal ring Progressive dilation followed by electrocauterization resulted in complete recovery

*Broncholithiasis*—The diagnosis of broncholithiasis is made in the majority of cases after a broncholith has been expelled during a paroxysm of coughing Hemoptysis, wheezing, dyspnea and at times pain are a not infrequent symptom complex A case is reported by Barrett<sup>28</sup>

The patient, a woman, had been ill for fifteen months with cough and recurrent fever A diagnosis of pneumonia was made during the course of this illness This responded to penicillin, but cough persisted Later the symptoms recurred During the course of pneumonia she expelled a small gritty mass which was thought to be a broncholith When the patient was admitted to the hospital, there was found definite evidence of an atelectatic process, with infection involving the lower lobe of the right lung At bronchoscopy a rough, irregular, grayish white calculus about 1 cm in diameter was found in the right main bronchus obstructing the lumen, proximal to the orifice of the middle lobe bronchus Following its removal, there was prompt improvement, and roentgen studies made three months later showed the right lung to be normal

Broncholithiasis is often associated with tuberculosis but may occur in a patient with no evidence of tuberculous infection Any persistent cough should suggest the presence of a broncholith, and a careful roentgenologic and bronchoscopic examination should be made While dramatic results follow removal of the broncholith, its persistence, producing obstruction of the bronchus, will lead to bronchiectasis

A majority of patients with broncholithiasis seek medical attention because of symptoms indicating bronchial obstruction or because of hemoptysis or expectoration of calculi Zahn<sup>29</sup> reported a case

The patient expectorated eight small, stony-hard, grayish white pieces of material varying in diameter from 2 to 5 mm The sputum contained tubercle bacilli Roentgen studies were considered to indicate that the chest was normal A review of serial films made several years prior to the expectoration of the calculi and films made just after their expectoration revealed a definite decrease in the number of calcifications that previously had been observed in the right hilus Several bronchoscopic examinations were performed, but the results were negative

The diagnosis was based on the definite history of expectoration of broncholiths, the disappearance of the calcified lesions seen on serial roentgenograms and the smear and the culture of sputum which were shown to contain tubercle bacilli

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27 Bence, A, and Bence, C A Stenosis of the Trachea, *Rev argent de broncho-esofagol* 2 52 (July) 1946

28 Barrett, J H Broncholithiasis, *Arch Otolaryng* 44 574 (Nov) 1946

29 Zahn, D W Broncholithiasis, *Am Rev Tuberc* 54 418 (Oct-Nov) 1946

Zahn reviewed the literature of broncholithiasis and found that the reported incidence of this condition is low when one considers the frequency with which calcification is observed in tuberculosis. This case demonstrates the potential dangers inherent in the so-called healed primary complex and again brings up for consideration the question whether calcified tuberculous lesions may harbor viable tubercle bacilli.

*Bronchial Asthma*—The treatment of bronchial asthma is primarily a function of the internist and more specifically of the allergist. Since many other pathologic conditions may produce symptoms suggesting bronchial asthma, Lell<sup>30</sup> has again emphasized the importance of keeping them in mind. It is in these that the bronchologist may be of aid not only in diagnosis but in treatment. This is particularly true in regard to children, in whom a foreign body present in the air or the food passage may be entirely unsuspected—in fact, not even considered. In reviewing the records of 176 children admitted for bronchoscopic examination because of symptoms simulating asthma but not responding to the accepted plan of therapy it was found that there were 18 cases of foreign body of the respiratory tract, 5 of foreign body of the esophagus and 23 of other organic changes. Several typical illustrative cases are summarized in the article.

The characteristic bronchoscopic findings made in cases of allergic pulmonary disease are described, and the mechanism underlying the production of dyspnea and wheezing is discussed. The collapse of the larger bronchi and the trachea tends to increase the amount of retained secretion and adds considerably to the respiratory distress of the patient.

In the majority of patients who were in status asthmaticus when examined bronchoscopically there was noted a marked hemorrhagic and edematous appearance of the mucous membrane of the trachea and of the larger bronchi with presence of thick, tenacious secretion. In addition many showed marked collapse of the posterior tracheobronchial wall. In status asthmaticus which does not respond to medical treatment, bronchoscopic aspiration of the secretion may often be a life-saving measure. Oxygen administered through the bronchoscope during aspiration aids in relieving the dyspnea. The results secured with bronchoscopic treatment in 102 patients who were in status asthmaticus are tabulated.

One of the cardinal features of bronchial asthma is the narrowing of the bronchial lumen which is produced by spasm, edema of the mucosa or both. While this change usually is found in small bronchioles, it may involve one or more of the larger bronchi, producing partial or complete occlusion. In studying the bronchostenosis of asthma one therefore must appreciate the many causes of bronchial occlusion.

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30 Lell, W. A. Bronchoscopy as an Aid in the Diagnosis and Treatment of Allergic Pulmonary Disease, Arch Otolaryng 43:49 (Jan) 1946

Mansmann and Osmond<sup>31</sup> emphasized the importance of roentgenologic studies of the chest in the diagnosis of bronchostenosis. It is important to secure films on inspiration and expiration or to examine the chest fluoroscopically or to do both. They emphasized the importance of complete allergic surveys if allergy is found to be an etiologic factor. When an acute infectious process is present, chemotherapeutic agents should be freely used. If the patients are under constant observation, bronchodilating drugs should be employed as long as symptoms are present, and if these become progressively worse or if there is roentgen evidence of a mediastinal shift suggesting atelectasis, bronchoscopy should be employed.

In a discussion of status asthmaticus, Cummings<sup>32</sup> reviewed the pathologic anatomy and the treatment with special reference to bronchoscopy and reported 4 illustrative cases. The most significant pathologic factors of status asthmaticus are the metamorphosis by which ciliated cells change to goblet cells and the atelectasis produced as mucus is propelled toward the larger airways.

The medical treatment of this condition requires a knowledge of many drugs that may be used to widen the airway, to aid elimination of mucus, to make it easy for oxygen to enter the alveoli, to rest the patient and to combat infection. Many of the patients are unable to get rid of secretions, and when roentgen studies and physical examination suggest the occurrence of patchy atelectasis, bronchoscopy is indicated. Cummings expressed the belief that, next to ridding the bronchus of secretions, the hyperventilation incident to deep inspiration during bronchoscopy is the most valuable feature of this procedure. Bronchoscopy, if carefully done, will do the patient no harm, and in most instances there will be a feeling of distinct benefit. It can be safely repeated as required.

In discussing the differential diagnosis of bronchial asthma Glaser<sup>33</sup> directed attention to the tragic mistakes that may be made if the physician does not realize that the physical signs and symptoms of asthma may be reproduced by the presence of an intrabronchial foreign body. This is especially true in infancy and childhood. The foreign body may almost always be diagnosed by roentgen examination, even if it is nonradiopaque, because of the local changes evoked by its presence. In case of any reasonable doubt concerning the diagnosis bronchoscopy is mandatory.

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31 Mansmann, J. A., and Osmond, L. H. Complications of Bronchial Asthma and Their Association with Bronchostenosis, *Pennsylvania M. J.* **49** 513 (Feb.) 1946.

32 Cummings, G. O. Status Asthmaticus, *Ann. Otol., Rhin. & Laryng.* **55** 136 (March) 1946.

33 Glaser, J. Differential Diagnosis of Bronchial Asthma in Infancy and Childhood, *Ann. Allergy* **4** 409 (Nov-Dec) 1946.

A survey of 250 cases of perennial bronchial asthma was made by Zoss and his associates<sup>34</sup> It was concerned primarily with the bronchoscopic findings and infection of the respiratory tract These cases were selected consecutively from a group of cases in which soldiers admitted to an Army general hospital because of asthma were given bronchoscopic examination in addition to the routine diagnostic study

Bronchoscopy was utilized to assist in excluding conditions that simulate asthma and to demonstrate infection of the bronchi It was noted that on many occasions information supplied by bronchoscopy was of considerable value in deciding the disposition of the case When chronic bronchial infection was revealed bronchoscopically, the asthma usually could not be satisfactorily controlled, regardless of how favorable the case appeared otherwise Consequently the occurrence of this complication was regarded as indicative of an unfavorable prognosis, and the asthma was evaluated accordingly

Bronchoscopy revealed bronchial abnormalities in 89.6 per cent of the series These were differentiated as chronic suppurative bronchitis in 49.2 per cent, chronic nonsuppurative bronchitis in 38.8 per cent and allergic bronchitis in 1.6 per cent

Chronic bronchial infection was noted in a significant number of young soldiers whose asthma was of relatively short duration Chronic suppurative infection of the respiratory tract was found in 73.2 per cent of all the patients

*Bronchography*—The diagnostic importance of bronchography is generally recognized, and a technic which is not too difficult or time consuming is desirable, so that bronchography may be practiced and rendered available to all patients who require it The method recommended by Poppe<sup>35</sup> is outlined in great detail Three fundamental principles are offered for obtaining a good bronchogram Employ adequate anesthesia Avoid delay between the injection of the oil and the taking of the roentgenogram Maintain constant traction on the tongue until the film has been taken A technic embracing the premedication, the anesthetizing of the pharynx and trachea, the posturing of the patient, the instilling of iodized oil into the trachea and the roentgenographic procedures is set forth in detail and should be carefully studied by any one contemplating bronchographic examination

The use of bronchography has clearly demonstrated that bronchiectasis is far more common in the tuberculous than suspected In a

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34 Zoss, A., Neidlinger, W. J., and Read, H. S. Survey of Bronchial Asthma in Soldiers. Bronchoscopic Findings and Incidence of Respiratory Infection, *J Allergy* **17** 87 (March) 1946

35 Poppe, J. K. A Simple and Practical Method of Obtaining Complete Bronchograms, *Am Rev Tuberc* **54** 104 (Aug) 1946



study of 50 patients who had pulmonary tuberculosis, Boyer<sup>36</sup> was able to demonstrate the presence of bronchiectasis in 85 per cent of those with the fibroid type of involvement and in 36 per cent of those with fibrocaceous lesions but not in those whose tuberculosis was of the exudative type. It was found in many patients in whom it had not been clinically suspected.

That bronchography should be more commonly used in the study of tuberculous patients is quite apparent. Several possible reasons for the failure to use it were discussed. One of these is the belief that spread of the disease is a likely consequence. In this study the instillations of iodized oil were performed by moderately inexperienced persons, yet very few reactions occurred, and no spread was observed with certainty. The writer expressed the opinion that bronchography is relatively innocuous if the patient is premedicated with  $1\frac{1}{2}$  grains (0.09 Gm.) of pentobarbital sodium to help prevent a tetracaine reaction.

*Reaction Following Bronchography*—Severe or fatal reactions occurring after intratracheobronchial instillations of iodized oil are relatively rare. In a review of the literature Mahon<sup>37</sup> found a number of reports, but with respect to many it was difficult to form any adequate opinion concerning the cause of death, and therefore one could not be certain that the reactions were due to iodized oil.

In the case reported by him the first symptom noted was a severe generalized convulsion. The patient was given  $7\frac{1}{2}$  grains (0.5 Gm.) of "amytal sodium" within one minute after the onset of the convulsion because the possibility of a cocaine reaction was considered. A few minutes later the patient became extremely cyanotic and stopped breathing. Artificial respiration was unsuccessfully carried out, and he was pronounced dead about ninety minutes after cocainization of the throat preliminary to instillation of iodized oil.

The final pathologic diagnosis, based on postmortem examination, was bilateral complete tracheobronchial obstruction due to inspissated mucus, massive pulmonary collapse and death from asphyxia. In addition there were noted bronchiectasis and pulmonary fibrosis.

Three cases of bilateral pneumonia which developed subsequent to intrabronchial instillation of iodized oil were reported by Kooperstein and Bass<sup>38</sup>. Sensitivity tests seemed to indicate that the iodized oil was the agent responsible for the acute pulmonary episodes. The bilateral basal lesions which developed in the portions of the lung fields in which iodized oil was previously instilled and the associated hives and

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36 Boyer, L. B. Bronchography in Tuberculosis, *Am. Rev. Tuberc.* **54** 111 (Aug.) 1946.

37 Mahon, G. S. Reaction Following Bronchography with Iodized Oil, *J. A. M. A.* **130** 194 (Jan. 26) 1946.

38 Kooperstein, S. I., and Bass, H. E. Pulmonary Reaction Following Intrabronchial Instillation of Lipiodol in Bronchial Asthma, *Am. J. Roentgenol.* **56** 569 (Nov.) 1946.

eosinophilia occurring in known cases of asthma suggested further investigation. It was of interest to note that in point of time elapsing between the instillation of the iodized oil and the development of pneumonia the latter resembled the delayed reaction of serum sickness.

*Cooperation of Anesthesiologist and Bronchologist*—Both the bronchologist and the anesthesiologist are actively interested in the study of respiration. Each deals directly with disease of the respiratory tract or with disturbances of respiration.

In a discussion of this problem, Cassels and Holinger<sup>39</sup> presented an analysis of the interlocking phases of the two fields, anesthesiology and bronchoesophagology, and methods by which these might be integrated for mutual benefit. While both specialists are concerned with the general condition and welfare of the patient, their points of view are slightly different. The anesthesiologist has a great deal to contribute to the work of the bronchologist, and it is to be hoped that the bronchologist will increasingly recognize the importance of having the cooperation of the anesthesiologist in many cases in which his assistance is of value. In cases of toxic reactions to drugs used to induce local anesthesia, the presence of an anesthesiologist may be of extreme value.

The administration of an anesthetic is not merely a technical procedure. It involves great hazards for the patient and requires judgment as to the choice of agent and method, dosage, diagnosis of complications and institution of appropriate treatment. The patient's welfare and even his life are placed in jeopardy whenever an anesthetic is administered. It has been the policy of the members of the medical profession to restrict to themselves the prerogative of jeopardizing the patient's welfare in the hope that benefit may result. It seems deplorable that in the field of anesthesiology this prerogative has been delegated to lay technicians who are quite incapable of using the fine judgment required. For this reason, as well as for that of obtaining the benefit of a wide selection of procedures, bronchologists, as well as other surgeons, are benefited by the assistance of trained anesthesiologists.

A completely new method of obtaining local anesthesia for endoscopic procedures is reported by Remorino<sup>40</sup>. This consists in nebulization of a solution of tetracaine hydrochloride, which the patient inhales by mouth for fifteen minutes prior to the bronchoscopic or esophagoscopy procedure. This anesthetizes the pharynx, larynx and trachea satisfactorily. The quantity of anesthetic used is negligible, usually not more than 2 cc. The nebulizer is not unlike that commonly employed

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39 Cassels, W. H., and Holinger, P. H. Points of Mutual Interest in Bronchology and Anesthesiology, *Ann Otol, Rhin & Laryng* 55:638 (Sept) 1946.

40 Remorino, A. G. Anesthesia by Nebulization for Bronchoscopy, *Rev argent bronco-esofagol* 2:25 (July) 1946.

and is efficient. The patient is able to anesthetize himself, so that while the bronchologist is busy the next patient, without any assistance, is anesthetizing himself.

*Reaction Following Anesthesia Induced with Tetracaine Hydrochloride ("Pontocaine Hydrochloride")*—With the increasing employment of tetracaine hydrochloride it is to be expected that toxic reactions will occur. Tetracaine is considered to possess fifteen times the anesthetic power of cocaine but is two and a half times as toxic in the same concentration. The toxic properties of tetracaine are similar to those of cocaine and other drugs used to produce local anesthesia. A case of overdosage of this drug has been reported by Ahroon<sup>41</sup>.

The patient, a 27 year old woman, was examined bronchoscopically without untoward effects following the employment of about 5 cc. of a 2 per cent solution of tetracaine hydrochloride. Ten days later she reported for bronchography, and after the pharynx had been sprayed with a 2 per cent solution of tetracaine hydrochloride and after 2 cc. of the solution had been instilled into the trachea and then an additional 2 cc. through the catheter into the bronchi, the patient complained of dizziness, and an excess of secretions appeared to accumulate in the trachea. She then had a generalized clonic convulsion of short duration, and after five similar convulsions she died in spite of intravenous administration of phenobarbital sodium, artificial respiration and other measures.

It was subsequently found that the solution of tetracaine hydrochloride used was stronger than 2 per cent. The strength of the solution was about 6 per cent, and the explanation was that it was kept in a poorly stoppered bottle and had concentrated itself by evaporation.

#### TUBERCULOSIS

*Tuberculous Tracheobronchial Lymphadenitis*—A tuberculous lymph node perforating into the tracheobronchial tree is probably more common than reports would indicate. Sayé and his associates<sup>42</sup> discussed this problem and presented a series of 7 cases. The ages of the patients varied from 9 to 27 years. In 6 of the cases the lesions occurred in the proximal and middle thirds of the main bronchi along the lateral wall.

The bronchoscopic appearances were those of an edematous and congested zone surrounding a small whitish lesion 2 to 3 mm. in diameter or a single ulcer 3 to 5 mm. wide with raised edges and draining caseous material. There may be a regressive type with irregular scarring and some calcification. Biopsy commonly reveals material suggesting a lymph node.

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<sup>41</sup> Ahroon, W. A. Report of a Death from Pontocaine Hydrochloride, *Laryngoscope* 56:320 (June) 1946.

<sup>42</sup> Sayé, L., Bence, A., and Fernandez Luna, D. Tracheobronchial Perforation in Tuberculosis of Intrathoracic Lymphnodes, *Rev. argent. de bronco-esofagol* 2:8 (July) 1946.

Many infections of childhood have been considered as causes of bronchiectasis. Recent data have shown a definite relationship between tuberculosis of the tracheobronchial tree, obstructive pneumonitis and atelectasis. Jones and her co-workers<sup>43</sup> reported a roentgenographic study of 716 children admitted to a hospital over a five year period in which 12 per cent of the roentgenograms showed segmental or lobar shadows suggesting obstructive pneumonitis. Forty-two of the patients were examined bronchoscopically, and in 31 there was found tuberculous involvement of a bronchus which appeared as endobronchial ulceration, granulation tissue or tuberculoma or as a compressive lesion caused by enlarged tuberculous lymph nodes.

A certain number of these patients were recalled several years later for study to determine whether bronchiectasis was present. A group of 37 were studied, and iodized oil was instilled. In 3 the oil could not be placed in the previously involved areas. Of the remaining 34, however, obvious signs of bronchiectasis were demonstrated in 24, or 70 per cent. Few of the 24 with bronchiectasis presented conspicuous symptoms. One was advised to submit to pneumonectomy.

From this study it is apparent that in children pulmonary tuberculosis is a common cause of bronchiectasis.

*Cytologic Study of Bronchial Secretions in Tuberculosis*—In bronchial secretions studied for neoplastic cells Herbut and Clerf<sup>44</sup> observed small or large clusters of unusual epithelial cells in some cases. On the basis of further studies they concluded that a presumptive diagnosis of pulmonary tuberculosis could be made from a cytologic study of smears made of secretions bronchoscopically removed and stained by the Papanicolaou technic. Of importance in the diagnosis is the presence of roundish clusters of ciliated epithelial cells, single ballooned and vacuolated ciliated epithelial cells and giant cells of the Langhans type.

This method is of particular value in differentiating pulmonary tuberculosis from carcinoma in patients in whom the lesions are atypically situated, in whom there is little constitutional disturbance and in whom examination of sputum has failed to reveal tubercle bacilli.

#### PNEUMOTHORAX

Bronchoscopy was employed by Troise and del Valle<sup>45</sup> in 3 cases of spontaneous pneumothorax in an attempt to clarify the mechanism

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43 Jones, E. M., Peck, W. M., and Willis, H. S. Bronchiectasis Following Primary Tuberculosis, *Am J Dis Child* **72** 296 (Sept.) 1946.

44 Herbut, P. A., and Clerf, L. H. Cytology of Bronchial Secretion. A Diagnostic Aid, in the Diagnosis of Pulmonary Tuberculosis, *Am Rev Tuberc* **54** 488 (Dec.) 1946.

45 Troise, C. A., and del Valle, F. Bronchoscopy in Spontaneous Pneumothorax, *Rev argent de broncho-esofagol* **2** 2 (July) 1946.

producing this condition. In all 3 cases it revealed bronchial obstruction due either to thick, viscid secretions or fibrinous material. Prompt recovery followed bronchoscopic removal. They concluded that bronchial obstruction may cause spontaneous pneumothorax by producing obstructive emphysema as demonstrated in their cases. Attention is directed to prompt bronchoscopic removal of the obstructing plugs.

#### FOREIGN BODIES IN THE AIR AND FOOD PASSAGES

Richardson<sup>46</sup> reviewed some of the salient clinical features of cases in which foreign bodies had lodged in various parts of the respiratory tract and emphasized certain pitfalls to be avoided in diagnosis and in treatment. The diagnosis of foreign body of the respiratory tract is easy if one remembers to think of the possibilities. The history of a foreign body accident should be accepted until proved wrong. Fluoroscopy of the chest is indicated when a nonradiopaque object is suspected. Roentgen examination should include the entire respiratory and the gastrointestinal tract. Safe removal of a foreign body is facilitated by having a duplicate of the object for comparison and practice and by making an adequate roentgen study, so that the location and the position of the object are understood. It is important to have at hand an instrumentarium\* adequate to deal with any complications that might arise.

The average physician is interested in two phases of the problem of the foreign body lodged in an air or food passage, namely, how to make the diagnosis and then what to do with the patient once the diagnosis has been made. In discussing this, Ferguson<sup>47</sup> emphasized the symptoms of aspiration and those of ingestion of a foreign body and the importance of roentgen studies. It is necessary for physicians to educate patients to be more foreign body conscious. If parents were aware of this need they would exercise more care in selecting foods and toys for children. They should be trained always to close safety pins. This would aid materially in eliminating a certain number of cases of foreign body, and many children would be saved unnecessary illness and at times death.

*Fluoroscopic Removal of Bronchial Foreign Bodies*—Objects located beyond the range of bronchoscopic vision should be removed only with the assistance of a biplane fluoroscope. Bence and Lanari<sup>48</sup> discussed

46 Richardson, J. R. Foreign Bodies in the Respiratory Tract, New England J. Med. **235** 707 (Nov. 14) 1946.

47 Ferguson, G. B. Diagnosis and Early Management of Inhaled and Ingested Foreign Bodies, North Carolina M. J. **7** 598 (Nov.) 1946.

48 Bence, A., and Lanari, C. Foreign Body in a Bronchus at the Costophrenic Location Removed with Help of Improvised Fluoroscope, Rev. argent. de broncoesofagol. **2** 82 (July) 1946.

the difficulty of dealing with such objects and reported their experience in removing a metal clip from the right bronchus in the costophrenic region. They used a makeshift fluoroscopic apparatus, which consisted of a portable and a regular apparatus combined. The bronchoscope was introduced and examination was made in the vertical plane with the regular apparatus, while the portable apparatus was used in the lateral plane. With this arrangement the foreign body was grasped and successfully removed.

Two cases of foreign body of the bronchus, a common pin in one and a dental burr in the other, were reported by Abalo<sup>49</sup>. In each instance the object was lodged in a subdivision of a lower lobe bronchus beyond bronchoscopic vision. Being without the aid of a double plane fluoroscope and too far from access to one, the author decided to try a single plane fluoroscope. In each instance the patient was placed in the lateral position and then rotated to the anteroposterior position, this was repeated a number of times until the forceps were approximated as close to the foreign body as possible, the blades were opened, the foreign body grasped and removed. The author very properly emphasizes that this should not be practiced routinely, as it is dangerous because of the possible traumatization of the bronchial wall.

Bernstein<sup>50</sup> removed a doughy mass, a tortilla, from the cervical portion of the esophagus of a man. Since the dough could not be grasped with forceps, an esophagoscope was passed into the mass, which adhered to its walls and also entered its lumen. With removal of the esophagoscope the mass also was removed and was found to measure 15 by 8 mm. The patient made a prompt and satisfactory recovery and suffered no ill effects from his experience.

Two cases in which the aorta was perforated by swallowed bones are reported by Haines<sup>51</sup>. In each instance esophagoscopy was performed several days after the accident. In neither could a foreign body be located. The lodging of a foreign body at the level of the aorta adds additional hazards because of the pressure exerted by the pulsating vessel, and this probably was a factor in the first case. The report emphasizes that the esophagus should be submitted to prompt direct examination when there is a history of swallowing of a foreign body with persistence of symptoms, even in the presence of a negative roentgenographic report.

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49 Abalo, M. A. The Extraction of Bronchial Foreign Bodies Situated Outside the Zone Accessible to the Bronchoscope, *Arch Soc estud clin Habana* 50 3 (March-April) 1946

50 Bernstein, D. Removal of a Tortilla from the Esophagus, *Arch Otolaryng* 43 629 (June) 1946

51 Haines, M. Perforation of the Aorta by Swallowed Bones, *Lancet* 2 455 (Sept 28) 1946

tion prior to operation disclosed a sinus opening on the right lateral wall of the esophagus in its middle third. Bronchoscopy revealed a fistulous opening on the posterior wall of the right main bronchus through which esophageal secretion was coming.

After surgical closure of the fistula, the patient made a very satisfactory recovery and remained free from symptoms. Pathologic studies of the tissue removed at operation revealed chronic inflammation and tuberculosis.

*Perforation of the Esophagus*—In 6 of 8 consecutive cases of perforation of the esophagus reported by Engler<sup>57</sup> the cause was foreign body, of the remaining 2 cases the cause in one was cauterizing lye ingested with suicidal intent and in the other syphilis. Of the 6 patients with esophageal perforation caused by foreign body, 2 were treated conservatively and experienced spontaneous recoveries. The other 4 were subjected to mediastinotomy, with recovery in 3 and death in 1 from a fulminating periesophageal infection that developed after removal of the foreign body, a denture. The patient whose bronchoesophageal fistula resulted from ingestion of lye died after being discharged from the hospital, by suicide, and the other, from the disease.

In all the cases roentgenographic examination and endoscopy were important in establishing the diagnosis. In 2 of the cases of esophageal perforation caused by foreign bodies the foreign bodies were not visualized roentgenologically, nor esophagoscopically, and were not removed.

Two cases of mediastinitis with esophageal perforation were reported by Grez<sup>58</sup>.

In the first, a case of cicatricial stenosis of the esophagus due to accidental ingestion of nitric acid, dilation was instituted, beginning with bougie no 12 and rapidly increasing to no 18. The patient then discontinued treatment but returned in nine months with dysphagia and ability to swallow only a small amount of liquid. Esophageal dilations were resumed, and then pains developed in the neck and the left side of the chest. Gastrostomy was done. A roentgen study revealed widening of the superior mediastinum, especially left sided, extending to the cervical region. This was interpreted as a mediastinal abscess, and 20,000 units of penicillin was given intramuscularly every three hours. In forty-eight hours the temperature returned to normal and pain disappeared. A total of 1,000,000 units of penicillin was given in five days. Roentgen studies showed complete disappearance of mediastinal shadows.

In the second case a woman of 33 years had gastric pain and dysphagia of four years' duration. Esophagoscopy revealed swollen esophageal mucosa and stenosis at the hiatal level. Following attempts at esophageal dilation, severe thoracic pain developed, radiating to the back. A roentgenogram showed widened

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57 Engler, C. W. Perforation of the Esophagus Not Caused by Instrumentation. Report of Eight Cases, *Ann Otol, Rhin & Laryng* 55:667 (Sept.) 1946.

58 Grez, A. Two Cases of Mediastinitis with Esophageal Perforation Treated with Penicillin Followed by Cure, *Rev argent de bronco-esofagol* 2:71 (July) 1946.

mediastinal shadows, and a diagnosis of mediastinitis due to perforation of the esophagus was made. Gastrostomy was done and penicillin administered. Recovery resulted, and the stenosis was treated by retrograde bougienage.

Knight<sup>59</sup> reported his experiences with various types of combat-incurred injuries involving the neck and the thorax. Several cases and the plans of treatment required are reported in detail. In one of these stenosis of the trachea, necessitating tracheotomy and later laryngostomy, developed over four months after the patient was injured in an explosion. He was exposed to carbon tetrachloride and possibly also to sulfur fumes. A hollowed acrylic obturator was employed and remained in the trachea for three months following the laryngostomy.

*Dysphagia*—In a discussion of the causes of dysphagia, Johnston<sup>60</sup> found it difficult to understand why knowledge of esophageal disease has been so backward, particularly when one recalls that the esophagus can be readily examined by direct means and its function studied by means of roentgenograms. While this article is presented largely from a roentgenologic standpoint, the subject has been thoroughly discussed and is well illustrated.

*Peptic Ulcer*—Peptic ulcer of the esophagus, long considered a rarity, was believed to be found mainly where there was a congenitally short esophagus. During the past five years, at the General Infirmary at Leeds, England, Allison<sup>61</sup> observed 37 patients with lesions proved to be peptic ulcers and 6 with esophagitis associated in all instances with diaphragmatic and gastroesophageal inefficiency. In his opinion the cases cannot be divided into two categories, for esophagitis is merely a stage in the development of the peptic ulcer.

Where the lower end of the esophagus is frequently digested by acid gastric juice, peptic ulcer of the esophagus will occur. This happens when inefficiency of the diaphragm allows the stomach and the abdominal portion of the esophagus to slide up into the mediastinum. Such herniation may be congenital or acquired. When medical measures fail to relieve symptoms, the problem becomes a surgical one, with replacement of the stomach in the abdomen and restoration of the length of the esophagus. The size of the hiatus may be diminished in order that the organs may be maintained in their normal positions. With chronic ulceration and fibrosis leading to inelasticity of the esophagus, anatomic restoration may not be possible.

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59 Knight, J. S. Injuries to the Trachea and Esophagus Occurring in Combat, *Ann Otol, Rhin & Laryng* **55** 656 (Sept) 1946.

60 Johnston, E. A. S. Dysphagia Due to Causes Other Than Malignant Disease, *Edinburgh M J* **53** 160 (April) 1946.

61 Allison, P. R. Peptic Ulcer of the Esophagus, *J Thoracic Surg* **15** 308 (Oct) 1946.



*Biopsy*—A frequent error encountered by the surgeon and the internist is that of the differentiation of early gastric carcinoma and benign ulcer. A biopsy specimen obtained with special forceps attached to the gastroscope provides positive evidence of the pathologic process. Kenamore and his co-workers<sup>66</sup> obtained 35 biopsy specimens without untoward reaction, in some instances they were unable to obtain tissue for biopsy by reason of a blind spot or inability to reach the involved area. The biopsy gastroscope was used only after a preliminary visual examination had been made with the examining gastroscope.

Four cases are presented with this report, in which the biopsy diagnoses were (1) adenocarcinoma, (2) lymphosarcoma, (3) hypertrophic gastritis and (4) chronic atrophic gastritis. This instrument permits a more exact study of gastric lesions and is safe in trained hands.

*Premedication for Gastrosocopy*—For successful gastroscopic examination it is important that the patient should be cooperative and mentally and physically relaxed. The type of sedative and anesthetic depend on the state of the patient. The patients examined by Monat<sup>67</sup> in the military service were between 20 and 30 years of age. This is a younger age range than that of patients encountered in civilian life, who are usually between 40 and 60 years of age.

It was found that "pantopon" (a mixture of hydrochlorides of opium alkaloids) gave the best results of all the drugs used, especially in the younger patients. Morphine was next best, although occasionally it produced a violent reaction. Meperidine hydrochloride ("demerol hydrochloride") with or without atropine proved most disappointing. As a result "pantopon" was preferred for younger patients and pentobarbital sodium ("nembutal") for older or less tense patients.

For local anesthesia, a 2 per cent solution of cocaine hydrochloride was applied to the posterior pharyngeal wall three times at three minute intervals and then to both piriform sinuses for about ten minutes, then 2 cc. of a 2 per cent solution of tetracaine hydrochloride was injected into the hypopharynx with a laryngeal anesthetizing tube. After a period of five minutes the patient was ready for gastroscopic examination.

*Fluorescein as an Aid*—Fluorescein has been used to outline ulcers of the cornea. This suggested to Robinson<sup>68</sup> that it might be used in the detection of erosions or ulcerations of mucous membrane surfaces. He used fluorescein topically by instilling 10 cc. of a 1 per cent solution

66 Kenamore, B., Scheff, H., and Womack, N. Study of Gastric Lesions by Means of Biopsy Specimens removed Endoscopically, Arch Surg **52** 50 (Jan) 1946.

67 Monat, H. A. Observations on Premedication with Various Drugs in Three Thousand Gastrosopies, Rev Gastroenterol **13** 440 (Nov-Dec) 1946.

68 Robinson, H. M. Fluorescein. An Aid in Gastrosocopy, Rev Gastroenterol **13** 303 (July-Aug) 1946.

of fluorescein sodium through an Ewald tube into the stomach after the gastric contents had been drained. Then gastroscopy was done. In a series of 22 cases there were 4 cases of superficial ulceration of the stomach. The dye aided in outlining and demonstrating the ulcer and also made it possible to estimate the diameter of the lesion more accurately.

*Gastroscopic Perforation of the Esophagus*—Complications following introduction of the flexible gastroscope have been rare. In the case reported by Paul and Antes,<sup>69</sup> considerable manipulation was necessary in order to pass the tube into the esophagus, and this undoubtedly was a factor in the perforation.

This accident occurred during the "1,711th gastroscopic examination" and resulted in a retropharyngeal abscess. The complication was promptly recognized, and forty-eight hours after the gastroscopic mishap a retropharyngeal abscess was drained through a lateral incision of the left side of the neck. No perforation of the esophagus was found. The patient ultimately recovered, although the postoperative course was fairly stormy.

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<sup>69</sup> Paul, W. D., and Antes, E. H. Perforation of the Esophagus Caused by Flexible Gastroscope, *Rev Gastroenterol* **13** 23 (Jan-Feb) 1946.

# Abstracts from Current Literature

## Ear

THE USE OF STREPTOMYCIN IN THE TREATMENT OF DIFFUSE EXTERNAL OTITIS  
BEN H SENTURIA and R H BROH-KAHN, *Ann Otol, Rhin & Laryng* 56 81  
(March) 1947

There have been many reports of the occurrence of *Pseudomonas* (gram-negative motile rods, growing on ordinary nutrient mediums and producing a characteristic water-soluble, chloroform-soluble greenish pigment) The authors feel that this organism may be the causative agent of diffuse external otitis It was found in a high percentage of the cases, it was not isolated from normal canals, successful treatment resulted in rapid disappearance of the organism, persistence of the organism was found in cases in which treatment failed to cure, and was observed prior to imminent relapse subsequent to cessation of therapy Treatment was carried on with 250 micrograms, 1 mg and 5 mg of streptomycin per gram of "carboprop" ointment base (60 parts of "carbowa 4000" and 40 parts of propylene glycol) "Carboprop" was used alone in a group of controls The weaker streptomycin ointments were no more effective than the ointment base alone, but the ointment containing 5 mg of streptomycin per gram of base gave promising and beneficial results One patient was given 100 mg of streptomycin parenterally every three hours for three days for a total of 24 Gm There was little improvement in this patient's condition

M V MILLER, Philadelphia

CRITICAL SURVEY OF THE LEMPERT ENDAURAL FENESTRATION OPERATION MARVIN  
F JONES, *Laryngoscope* 57 263 (April) 1947

Jones surveys the Lempert fenestration in all its aspects The discussion of these various phases is most interesting and helpful Any one contemplating fenestration surgery should be mindful of all Jones emphasizes, particularly that pertaining to the necessity of possessing particular surgical ability and thorough training

HITSCHLER, Philadelphia

DR PROSPER MENIERE A HISTORICAL SKETCH WALTER A WELLS, *Laryngoscope*  
57 275 (April) 1947

It was Prosper Meniere, rather than Emile Antonine Meniere, his son, who first commented on the condition now commonly referred to as Meniere's disease or syndrome His son, an otologist, has frequently been given the credit for the discovery

To quote Prosper Meniere's report of his well known case, the semicircular canals were filled with a "reddish plastic exudate" Later, this statement was misquoted, to the effect that there was a labyrinthine hemorrhage It was the misquoting that largely discredited Meniere's diagnosis His original description can hardly be improved on today

Wells mentions other interesting facts concerning the discovery and history of the syndrome

A bibliographic sketch of Prosper Meniere is given

HITSCHLER, Philadelphia

THE FENESTRATION OPERATION AN EVALUATION OF ITS PRESENT STATUS  
G E SHAMBAUGH JR, Surg, Gynec & Obst **84** 828 (Feb) 1947

Shambaugh proposes to classify cases for surgical fenestration of the labyrinth as follows

"Class A Ideal Normal hearing by bone for speech frequencies Prognosis 8 in 10 chances of permanent hearing improvement within the 30 decibel practical level

"Class B Suitable, but not ideal Normal hearing by bone except for one of the speech frequencies that shows a loss of 30 decibels or more Prognosis 50-50 chance of sufficient gain to do without a hearing aid

"Class C Experimental Two or more of the speech frequencies show a 30 decibel or greater loss by bone but the Rinne test for the 1024 fork is negative Prognosis A remote 1 in 10 chance of sufficient improvement to give practical hearing without an aid

"Class D Unsuitable due to incomplete stapes fixation or to profound nerve degeneration Operation contraindicated"

He urges that the poorer hearing ear be chosen for this operation to minimize any risk to the patient's better hearing ear Audiometric measurements on bone conduction should be performed with adequate masking of the opposite ear In addition, testing with certain tuning forks is of value Among these are 64, 512, 1024 and 2048 forks Inability to hear the 64 fork indicates complete fixation of the stapes, ability to hear the fork at moderate intensity signifies only partial fixation of the stapes, and here surgical intervention offers too little to be worth while A Rinne test with the 1024 fork which gives a negative result offers a favorable operative result even though the patient may fall into class B or C A Rinne test with the 512 fork which gives a positive result usually implies only partial fixation of the stapes and is a contraindication to surgical treatment If the 2048 fork is not heard by bone (with masking), the prognosis is extremely poor

Various modifications of the technic of surgical fenestration of the labyrinth have been proposed Final decision as to which technic is the most reliable will probably await a comparative statistical analysis of the different methods From the point of view of the patients 82 per cent of those operated on by the author and his associates regard the procedure as successful and do not use a hearing aid

An interesting question is raised concerning the possible arresting effect of successful fenestration on eighth nerve degeneration Further evidence will be needed for evaluation of this possibility The risks of the operation are minimal, being chiefly to the facial nerve and the labyrinth There is a tendency at present to regard the hearing results found two years after operation as permanent

FRIEDBERG, Chicago

CONSIDERATION OF HEARING IMPAIRMENT IN THE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA J H MAXWELL, Surg, Gynec & Obst **84** 845 (April) 1947

Attention is directed to the fact that the preservation of residual hearing or the improvement of hearing is not the major concern in dealing with chronic suppuration of the middle ear The otologist must be mindful of the extent and dangers of the infection and, having dealt adequately with this factor, pursue a course which will tend to preserve all residual hearing or even improve the

auditory acuity Individualization of each case is required, and routine methods of therapeutics in dealing with chronic disease of the middle ear are to be discouraged A thorough history and a detailed examination are prerequisite, signs and symptoms of extension of the infection must be watched for, and the significance of various types of tympanic perforations and secretions should be well understood

The anterior inferior or "tubal" perforations require treatment directed to the nose and the nasopharynx, and antiseptic solutions should be applied locally to the tympanum Large marginal perforations with granulations of the promontory but without cholesteatoma may be treated conservatively A hearing loss of around 30 to 40 decibels usually accompanies this type of lesion

Attic involvement or posterosuperior marginal perforations with odorous secretion usually imply serious potentialities A hearing loss of 50 to 60 decibels may be present Radical mastoidectomy is frequently indicated, and one should expect complete healing in over 95 per cent of adult patients Hearing will not be restored but may be improved or may be lost entirely in the ear operated on Procrastination may lead to intracranial complications, and the author stresses the fact that indications for radical mastoidectomy are present and must be discovered before a complication occurs

The primary form of acquired cholesteatoma with attic perforation is often characterized by reasonably good hearing and may occasionally be treated successfully by irrigations of the attic If operation is required, the attic mastoidectomy described by Lempert is the procedure of choice Preservation of the pars tensa assures the maintenance of tympanic air space about a stapes which has not been disturbed and offers an excellent prospect of obtaining a dry ear with preservation of serviceable hearing This of course is preferable to the classic radical mastoidectomy with its proportionately greater loss of hearing

FRIEDBERG, Chicago

## Pharynx

IRRADIATION OF THE NASOPHARYNX SAMUEL J CROWE, *Ann Otol, Rhin & Laryng* 55 779 (Dec) 1946

Crowe discusses the genesis of his radiation treatment of the lymphoid tissue of the nasopharynx He points out the fact that the lymphoid tissue of the nasopharynx is an integral part of the mucous membrane and that in some children it will hypertrophy as a result of infection, allergy and other causes which are not understood It was found that over 75 per cent of children who underwent adenoidectomy before puberty had recurrence and that nearly 40 per cent of these had either impaired hearing for high tones alone or for all tones of the speech range The postoperative regrowth of this adenoid tissue predisposes to recurrent infections of the upper respiratory tract, attacks of suppurative otitis media, sinusitis and bronchial infections In view of this he and his associates have, for several years, supplemented tonsillectomy with irradiation of the nasopharynx The first treatment is given two weeks after operation, and two more are given at two week intervals Operative removal of large adenoids followed by a series of radium treatments is always more satisfactory than irradiation alone

Often there is compensatory hypertrophy of lymphoid nodules in the pharynx and nasopharynx after removal of the tonsils and adenoids Even though these may be small in size, they may be so placed that they interfere with the function of the eustachian tubes Radiation is of great value in restoring patency of these

tubes. Nodules of hyperplastic and infected lymphoid tissue occurring in the nose near the posterior end of the middle turbinate may cause symptoms resembling those of vasomotor rhinitis. Crowe believes that lymphoid tissue in this position is a common cause of ethmoiditis and sphenoiditis in children. Lymphoid nodules in the nose and about the eustachian tube are often so small that they can be seen only with the nasopharyngoscope. They should be looked for, and if present, removed by irradiation rather than by surgical excision or cauterization. Edema is a constant factor following irradiation, so it is advisable to omit treatments during acute infection of the respiratory tract, and in the presence of subacute or chronic infections, to allow a three or four week interval between treatments.

The technic of anesthetizing childrens' noses for the examination is described, and the placing of the applicator and the dosage of the radiation are well covered.

M. V. MILLER, Philadelphia

#### A METHOD OF MINIMIZING CONTRACTURE FOLLOWING CLEFT PALATE OPERATIONS

H. BAXTER and M. CARDOSO, *Plastic & Reconstr Surg* 2:214 (May) 1947

The authors present a modification of methods already in use for the correction of cleft palate. A dental compound stent is molded to fit the space concerned, and around this a split skin graft from a hairless area of the body is wrapped with the raw surface outward. The use of the stent keeps the skin graft in close contact everywhere with the mucoperiosteal flap and with the bony palate. This favors a complete union of the tissues and also prevents premature contraction of the skin graft. Two or three weeks later the usual push-back operation is performed.

After the second operative stage it is particularly important that the skin graft be trimmed away from the edges of the palatal flap, to allow enough raw surface to unite with the adjacent part of the palatal bone. Wire or dermal sutures are used to prevent the tip of the flap from moving forward. The cleft is then closed in the usual way. Four to six weeks after the operation is completed, the authors favor palatal massage to increase mobility. Results have been uniformly satisfactory including those following speech training.

SELTZER, Philadelphia

### Larynx

LARYNGEAL EDEMA, MYOCARDITIS AND UNEXPECTED DEATH (EARLY ACUTE LARYNGOTRACHEOBRONCHITIS). OTTO SAPHIR, *Am J M Sc* 210:296 (Sept) 1945

The author reports 5 cases of rapidly developed symptoms of obstruction of the upper respiratory tract, the patients succumbed quickly despite tracheotomy. Autopsies disclosed severe laryngeal edema, edema of the epiglottis and subglottic area and acute myocarditis. The edema is interpreted as an early stage of so-called laryngotracheobronchitis. The unexpected death was probably caused by myocarditis. If in future instances the attending physician is aware of this complication, supportive measures might forestall the fatal outcome.

HENSKE, Omaha [*Am J Dis Child*]

A REVIEW OF TUBERCULOSIS IN THE FIELD OF OTOLARYNGOLOGY FOR THE PAST YEAR. FRANK R. SPENCER, *Laryngoscope* 57:97 (Feb) 1947

The problem of relieving pain in the tuberculous larynx has been discussed by several authors. Bueno obtained good results by parenteral administration of a solution called the compound A of Gillet (a 1 per cent solution of a purified oil or resin). LeLourd favors infiltrating procaine hydrochloride into the carotid

sinus, while Myerson had good results using a sulfonamide compound in a spray. Auerbach presented figures resulting from gross and microscopic studies of lesions at autopsies.

Several authors discussed various therapies. Streptomycin, used both locally and parenterally, shows much promise. Spencer feels that this drug is one of the most outstanding contributed to the treatment of tuberculosis in many years.

HITSCHLER, Philadelphia

CARCINOMA OF THE LARYNX, ITS DIAGNOSIS AND TREATMENT. CLAUD C. CODY JR., Texas State J. Med. **42** 495 (Dec.) 1946

The author stresses the importance of early accurate diagnosis of laryngeal cancer and states that such diagnosis combined with appropriate treatment converts a previously incurable condition with a mortality rate of 100 per cent into one the mortality rate of which is approximately 15 per cent. Hoarseness is given as the earliest and most persistent symptom of carcinoma of the vocal cords, but headache is mentioned as the most common of all symptoms. The presenting symptom is dependent on the location of the lesion. In intrinsic cancer the early presenting symptom is hoarseness. In extrinsic cancer of the larynx the presenting symptoms are all late, fortunately, this type of cancer is rare. The locations in order of frequency are the vocal cords, the piriform sinus, the subglottis, the epiglottis, and the space anterior to the epiglottis. Carcinoma may be suspected by its appearance and location, but a definite diagnosis is made from a specimen taken, after induction of local anesthesia, by direct laryngoscopy and use of a punch forceps. Pachyderma, tuberculosis and syphilis must be considered in making a differential diagnosis of the lesion.

Broders' classification is of value in the selection of the treatment of choice.

In children papilloma of the larynx is dangerous only when it reaches sufficient size to obstruct breathing, but in adults, young or old, papilloma of the larynx is always potentially serious, frequently it is malignant. In the treatment of laryngeal cancer the method of choice is dependent on many factors. The duration of the disease, the location, the size and the degree of malignancy of the tumor, the age and the general health of the patient are all factors to be considered. Carcinoma grade 4 should be irradiated in accordance with the Coutard technic, while surgical removal is indicated for grades 1, 2 and 3. Local anesthesia induced with pentothal sodium is the anesthesia of choice for laryngeal surgery.

SINGLETON, Dallas, Texas

## Nose

ANTIBIOTICS IN THE TREATMENT OF SINUS INFECTIONS. HARRY P. SCHENCK, Ann. Otol., Rhin. & Laryng. **56** 38 (March) 1947

The majority of acute sinus infections were adequately managed before the introduction of chemotherapy. The main advantage of antibiotic substances and sulfonamide compounds lies in their ability to control infections resistant to the ordinary rhinologic procedures, so that surgical intervention is either avoided or limited to simpler procedures. Penicillin, streptomycin and thyrothricin are the only antibiotics which have been found important, and each has a special sphere of use. They do not entirely replace the sulfonamide compounds, and frequently the two groups are beneficial when used together. Antibiotics are of little or no value in uncomplicated allergy but are useful in treating secondary infections. They

should not be used to prevent secondary infections, nor should they be used in mild and transient infections, as patients may become allergic to the antibiotics themselves, and it has long been recognized that immunity often is not acquired when an infection is promptly controlled by chemotherapy

The rule that as little surgical intervention as possible should be employed in acute sinus infections is more definite since the introduction of chemotherapy, often even though orbital extension, bacteremia and retrograde thrombosis have occurred. Timely chemotherapy has almost eliminated these complications, and when they occur they may usually be readily controlled by chemotherapy. With or without chemotherapy, most sinus infections should be allowed to become chronic before resorting to surgery. Once collections of pus have developed, however, drainage must be established in spite of continuous chemotherapy.

Antibiotic therapy is not a cure-all, as it is effective only when directed against sensitive organisms, and, whenever possible, the vulnerability of the organism should be determined by sensitivity tests before treatment is started.

Chronic sinusitis is, in the main, resistant to antibiotics, as the drugs penetrate the tissues with difficulty. Tyrothricin does not penetrate tissue at all and is of use only against surface infections, so it is useless in cases of chronic infection. Though penicillin and streptomycin may control the chronic infection temporarily, recurrence frequently follows their withdrawal. Penicillin is not inhibited by organic matter, as is the action of the sulfonamide compounds, but it cannot penetrate collections of pus. Streptomycin loses some activity in the presence of body fluids. It is less toxic than the sulfonamide compounds but more toxic than penicillin, and among its more serious effects are toxic involvement of the vestibular and cochlear nerves, allergic-like reactions of skin and joints and certain renal effects.

During the operative period, antibiotics, used locally and systemically, have prophylactic value in preventing complications, and during the postoperative period they limit the spread of infection and tend to shorten the healing period.

The ears and the sinuses are the most frequent sites of primary foci of infection in meningitis. A combination of antibiotic and sulfonamide therapy plus eradication of the primary focus appears to give the most consistent permanent results. This is the wisest course in spite of the fact that frequently initial attacks of meningitis may be controlled by chemotherapy without surgical drainage. Even though osteomyelitis may be controlled by antibiotic therapy, healing occurs only after all necrotic bone has been removed.

M V MILLER, Philadelphia

DIAGNOSIS AND TREATMENT OF SINUSITIS    MARCOS COHEN B, *Rev de otorrinolaring* 6 149 (Dec) 1946

Basing his observation on a series of 150 cases of acute and chronic sinusitis, Cohen attempts to evaluate present day concepts of the problems that arise. He reviews the symptoms, the diagnosis and the treatment of the various types of sinusitis. Two important conditions are stressed: (1) suppurative maxillary sinusitis, which may be present even though there is no evidence of a purulent discharge in the middle meatus, and (2) the so-called primary neuralgias of the ophthalmic and the superior maxillary nerves. The author believes that these neuralgias are directly due to pathologic conditions developing in the posterior series of the sinuses, i. e., the posterior ethmoid and sphenoid sinuses.

The diagnosis is comparatively simple when a careful history is taken and a thorough physical examination is made, with the added use of transillumination, nasopharyngoscopy and antroscopy, and roentgen examination.



Cohen stresses the importance of conservative medical treatment and uses surgical methods only after conservative medical treatment has been given a thorough trial and has failed to produce satisfactory results. Either a sulfonamide compound or penicillin was used in the acute cases. The drug was administered either parenterally or orally. Local application of either drug did not show any real value. The author usually supplements intensive sulfonamide therapy with protein therapy.

When surgical intervention is indicated, Cohen employs the Caldwell-Luc operation for maxillary sinusitis, the intranasal operation for ethmoiditis and Riedel's technic for frontal sinusitis. For pansinusitis he employs de Lima's technic, and for simple sphenoiditis he prefers Segura's transseptal approach. He supplements surgical treatment with postoperative chemotherapy in all cases.

PERSKY, Philadelphia

### Miscellaneous



NOTES ON THE PATHOLOGY OF CRANIAL TUMORS. I. OSTEOMAS OF THE SKULL, WITH INCIDENTAL MENTION OF THEIR OCCURRENCE IN THE ANCIENT INCAS. KENNETH H. ABBOTT and CYRIL B. COURVILLE, *Bull. Los Angeles Neurol. Soc.* 10:19 (March-June) 1945.

Abbott and Courville report on osteoma of the skull, which is probably the most common of all new growths involving the cranium. However, osteoma is relatively rare, especially if sufficiently large to necessitate surgical attention. Tumors of this type have been recognized since the time of Galen. It is stated that the incidence in the larger neurosurgical clinics is approximately 1 per cent.

The specimens are classified into four types: (1) circumscribed osteoma of the cranial vault, (2) diffuse osteoma, arising most commonly from the sphenoid or the temporal bone, (3) osteoma of the orbitoethmoidal or orbitomaxillary region, and (4) osteochondroma of the cranial floor.

Specimens of the circumscribed osteoma of the cranial vault may be subdivided into (1) the small and usually subclinical osteoma eburneum, which arises by a broad base with either an indistinct or a sharply circumscribed border, and (2) osteoma spongiosum, which is a larger, more rapidly growing tumor and has a central portion of cancellous bone. The latter tumor sometimes becomes large and pedunculated and requires surgical excision, especially when the inner table of the skull is eroded and some degree of pressure on the underlying structures results in neurologic symptoms.

The diffuse osteoma, arising most commonly from the greater wing of the sphenoid bone, from the petrous portion of the temporal bone or, more rarely, from the orbital roof, is an unusual, slowly growing tumor, the orbital variety of which often produces exophthalmos and casts a dense paraorbital shadow on the roentgenogram. It is usually amenable to surgical excision.

The orbitoethmoidal (or orbitomaxillary) osteoma is said to have its origin in a cartilaginous rest which persists in the line of the frontoethmoidal (or maxilloethmoidal) suture line. It may have a complex localization, invading two or more of the regional cavities (orbit, frontal or ethmoid sinus, or cranial chamber), or may be confined within a single cavity, growing eccentrically from a well defined focus. Within such a cavity, the osteoma may become completely detached from its pedicle, an event resulting in the formation of a "dead osteoma," which is biologically inert.

Osteochondroma arising from the cranial floor is an extremely rare growth, but, because it extends upward into the intracranial space, it is to be classified as one of the many possible tumors which may compromise the intracranial space

The available facts regarding the location and development of the various types suggest that osteoma is the result of some perversion of the union of the suture lines, possibly with formation of isolated cell rests of osseous or cartilaginous character

GUTTMAN, Philadelphia [ARCH NEUROL & PSYCHIAT]

STUDIES ON ORAL PENICILLIN JOHN S GORDON, *Laryngoscope* **57** 202 (March) 1947

Gordon studied the effect of orally administered penicillin in diseases of the ears, nose and throat Blood serum levels were determined, and the sensitivity of the offending organism also was determined Fifty thousand units was given every two to three hours Such doses gave blood levels eight to ten times higher than the threshold of sensitivity of the pathogenic organisms found In children 25,000 units sufficed A satisfactory therapeutic effect resulted Several untoward reactions were encountered

HITSCHLER, Philadelphia

INTELLIGIBILITY RELATED TO ROUTINIZED MESSAGES HENRY M MOSER, *Speech Monogr* **13** 47, 1946

Even in 1943 the four voice messages uttered over the interphone system of the multiplace airplane were almost completely unsystematized Since it had been shown that systematic procedures and routinized messages increased intelligibility, the voice communication laboratory at Waco, Texas, was presented with the problem of developing a routinized procedure The first step was to find the topics, wordings and relative efficiency of current interphone practices Nearly 2,500 transmissions were recorded Analysis showed these to relate to over 200 topics of business Of the 1,500 messages that elicited a verbal response from a listener, 40 per cent of the responses were asking in one wording or another that the original transmission be repeated The second step was to treat with the order and the words of the routines that necessarily surrounded the messages The following summary sequence accommodated these requirements X alerts Y for a message, Y signals readiness for message, X sends and ends message, Y acknowledges message Experiments were conducted in which alternative wordings and orders of messages were tried Obviously, understandability can be improved by the routine use of single purpose words Therefore, different name words, for the most part ones already in use, were tried out for each position in the manner described For example, the names that were tried for one station were "ball turret," "ball turret gunner," "belly gun" and "ball gun" The third step in the formulation of the procedure was to select words for the message The method was to study the job analysis recordings for potential topics For example, a multiplicity of terms was in common use the sense of which was to ask for repetition of a message Half of them were on the order of "what," "what did you say" and "huh" Others conformed to current or outmoded radiotelephone phrases, and the remainder were bizarre, such as "Put your teeth in, so I can hear you" Finally, devices were borrowed to improve intelligibility through the manner in which words were presented

PALMER, Wichita, Kan

INTELLIGIBILITY RELATED TO ARTICULATION    GAYLAND L. DRAEGERT, Speech Monogr **13** 50, 1946

Four experiments, three of which were preliminary, were designed to investigate the effects of training of pronunciation or articulation. Thirty-seven student pilots were tested and trained for one class hour in clear pronunciation of words, and retested. Thirty-eight other students were used as a control group. Training given in articulation covered one fifty-five minute class period on the day between the initial and the final test. The training hour included instruction as to the need of clear articulation, presentation of words containing sounds of low intelligibility, drilling in noise with lists of low intelligibility, demonstration recording "articulation", drilling with interphone messages in noise. The control group showed no gain, while the experimental group gained about 61 points with difficult words. Results show that training for good articulatory patterns is likely to improve intelligibility and is superior to training which attempts to improve the pronunciation of "difficult" sounds only.

PALMER, Wichita, Kan

UNDERSTANDABILITY OF SPEECH IN NOISE AS AFFECTED BY REGION OF ORIGIN OF SPEAKER AND LISTENER    HARRY M. MASON, Speech Monogr **13** 54, 1946

Speakers from the various Service Commands of the United States Army were identified, and intelligibility tests for 1,913 men were analyzed. In making these tests of differential intelligibility, only speakers who were heard by listeners from both regions in question were considered. The various Service Commands had significant differences between them in intelligibility for both speakers and listeners. Real differences in speaking ability for areas are likely but not definitely proved. The Fourth and Sixth Service Commands averaged high in speaking ability, the Eighth, low. The Sixth Service Command furnished outstandingly good listeners. Educational factors, perhaps accounting for some of these differences, should have been minimized, since only familiar one syllable and two syllable words were used in tests, and misspelling was not considered an error. The presumption is that if more precisely defined speech regions formed the basis for analysis instead of Service Commands, greater differential understandability would be discovered.

PALMER, Wichita, Kan

## Book Reviews

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**Lehrbuch für Hals-Nasen-Ohren-und Mundkrankheiten** By A Barraud, Lausanne, F R Nager, Zurich, L Ruedi, Bern, E Schlittler, Samaden, and J P Tailens, Lausanne, Switzerland Price, 60 Swiss francs Basel, Switzerland S Karger, Ltd, 1947

This is a well written textbook about the ear, nose, throat and mouth. The German in it is concise and easy to read and practically translates itself to one already versed in otolaryngologic terminology.

The many illustrations and colored plates are beautifully done, giving a real image of the usual and the unusual conditions of the ear, nose, throat and mouth.

Extreme detail has been omitted in the descriptions of many of the radical operations—for example, frontal sinusotomy—and rightly so, since the book is obviously not meant for the expert otolaryngologist, nor even for the serious post-graduate student. Also, it lacks a complete written and visual description of bronchoscopy and esophagology such as is given generally in so many American books and in particular in that of Jackson and Jackson on otolaryngology.

There is a fine allotment of space for the more frequent diseases, with less space for the infrequent ones, giving a fairly well balanced reference book for the medical student and the general practitioner versed in the German language and continental nomenclature. It is completely modern and up to date in its theoretic considerations and its therapy and hence is of distinct value as a forward step in the rapidly changing panorama of otolaryngology.

**Textbook of the Ear, Nose and Throat** By Francis L Lederer, M D, and Abraham R Hollender, M D Pp 579 Price, \$7

This text has some superior plates and illustrations. It should prove a boon to the harried instructor and the confused student. Of course, one must remember, that it is on an undergraduate level, it has no place at all in graduate study. Indeed, it gives only the merest suggestion of otolaryngologic importance and depth.

However, to a busy student of medicine, surgery and obstetrics, it can and will implement the few concise lectures which are allowed for the study of ear, nose and throat.

There is an orderly and thoroughly satisfactory classification of the main conditions as they are seen in otolaryngologic practice. The reading is easy and uninvolved. Each chapter is preceded by a small inclusive review, giving the highlights of its contents.

Operative procedures are described rather vaguely, and many are left out completely. Bronchoscopy is handled lightly, but these things are as they should be in a minor textbook for undergraduate students.

In general, it might be said that this volume is a worth while addition to a medical student's library.

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## LEMPERT DECOMPRESSION OPERATION FOR HYDROPS OF THE ENDOLYMPHATIC LABYRINTH IN MÉNIÈRE'S DISEASE

JULIUS LEMPERT, M D  
NEW YORK

MÉNIÈRE'S DISEASE, the cause of which is still to be determined, is diagnosable only through the process of exclusion. It consists of repeated sudden, severe attacks of vertigo with spontaneous nystagmus occurring at intervals of unpredictable frequency and duration. The attacks are accompanied with severe tinnitus, in addition to a loss of perceptive hearing which usually progresses with each attack. If allowed to continue, the paroxysmal attacks usually result in complete inner ear deafness. As a rule, the vestibular function when tested between attacks shows diminished response as compared with that of the nonaffected ear. These attacks are usually accompanied with nausea and vomiting.

### PATHOLOGIC ASPECTS

In 1938 Hallpike and Cairns<sup>1</sup> first observed a hydrops of the vestibular and cochlear portions of the membranous labyrinth on histologic examination of the temporal bone of the affected ear in 2 cases of Ménière's disease which came to autopsy. In 1940 Hallpike and Wright<sup>2</sup> were able to make the same observation in another case. These observations have been confirmed by Lindsay<sup>3</sup> in 1942 and by Altman and Fowler Jr.<sup>4</sup> in 1943.

On the basis of these histologic observations of hydrops occurring within the labyrinths of patients known to have suffered from Ménière's disease, it became logical to reason that the signs and symptoms of Ménière's disease are most likely caused by this hydrops of the endolymphatic labyrinth. The etiologic factors precipitating such hydrops are still to be determined.

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From the Lempert Research Foundation, Inc.

1 Hallpike, C. S., and Cairns, H. *J. Laryng & Otol* **53** 625, 1938.

2 Hallpike, C. S., and Wright, A. J. *J. Laryng & Otol* **55** 59, 1940.

3 Lindsay, J. R. Labyrinth Dropsy and Ménière's Disease, *Arch. Otolaryng.* **35** 853 (June) 1942.

4 Altman, F., and Fowler, E. P., Jr. *Ann. Otol., Rhin. & Laryng.* **52** 52, 1943.

## SURGICAL TREATMENT OF MÉNIÈRE'S DISEASE

Both the clinical picture and the histologic aspects of Ménière's disease permit the conclusion that it is a disease limited entirely to the internal ear and that both the vestibular and the cochlear portion thereof are involved

It is therefore logical to assume that by effecting the complete degeneration of both the vestibular and the cochlear part of the endolymphatic labyrinth in a case of monaural Ménière's disease, and thus preventing the recurrence of endolymphatic hydrops, it should be possible permanently to relieve the patient of the vertigo, which is vestibular in origin and the tinnitus, which is most likely of cochlear origin. A treatment of Ménière's disease cannot be considered completely adequate unless it relieves both of these distressing symptoms

DOES PARTIAL DESTRUCTION OF THE VESTIBULAR PORTION OF THE MEMBRANOUS LABYRINTH RESULT IN DEGENERATION OF THE ENTIRE ENDOLYMPHATIC SYSTEM?

It is a well recognized fact today that partial section or electrocoagulation of the vestibular portion of the endolymphatic labyrinth through a fistula created in the external semicircular canal, though as a rule resulting in cessation of the paroxysmal attacks of vertigo, seldom relieves the tinnitus. Believing as I do that the complete degeneration of both the vestibular and the cochlear portion of the endolymphatic labyrinth should prevent the recurrence of endolymphatic hydrops and result in permanent relief of both the vertigo and the tinnitus in Ménière's disease I could not help but question whether degeneration of the entire vestibular and cochlear endolymphatic labyrinth is ever accomplished by partial destruction of the vestibular portion of the labyrinth

In my pursuit of a research study of this problem, my attention was attracted by the clinical observation that when the external semicircular canal of the endolymphatic labyrinth was accidentally destroyed or removed during the performance of the fenestration operation for clinical otosclerosis the accident did not always result in a still further recession of the preoperatively impaired hearing. Such observation strengthened my belief that partial vestibular labyrinthectomy does not necessarily always result in degeneration of the entire endolymphatic system

However, not until I carefully studied histologically the internal ears of our experimentally fenestrated rhesus monkeys<sup>5</sup> was I convinced that destruction of the vestibular portion of the labyrinth when performed under sterile precautions did not result in degeneration of the rest of the endolymphatic labyrinth and of the organ of Corti

5 Lempert, J., Meltzer, P. E., Schall, L. A., and Wolff, D. Osteogenesis Following Fenestration of the Vestibular Labyrinth of the Rhesus Monkey. A Controlled Experimental Study. *Arch. Otolaryng.* 46:512 (Oct.) 1947

Figures 1 to 5 show photomicrographs of the endolymphatic systems of the experimentally fenestrated labyrinths of these rhesus monkeys, proving that destruction of the vestibular portion of the mem-

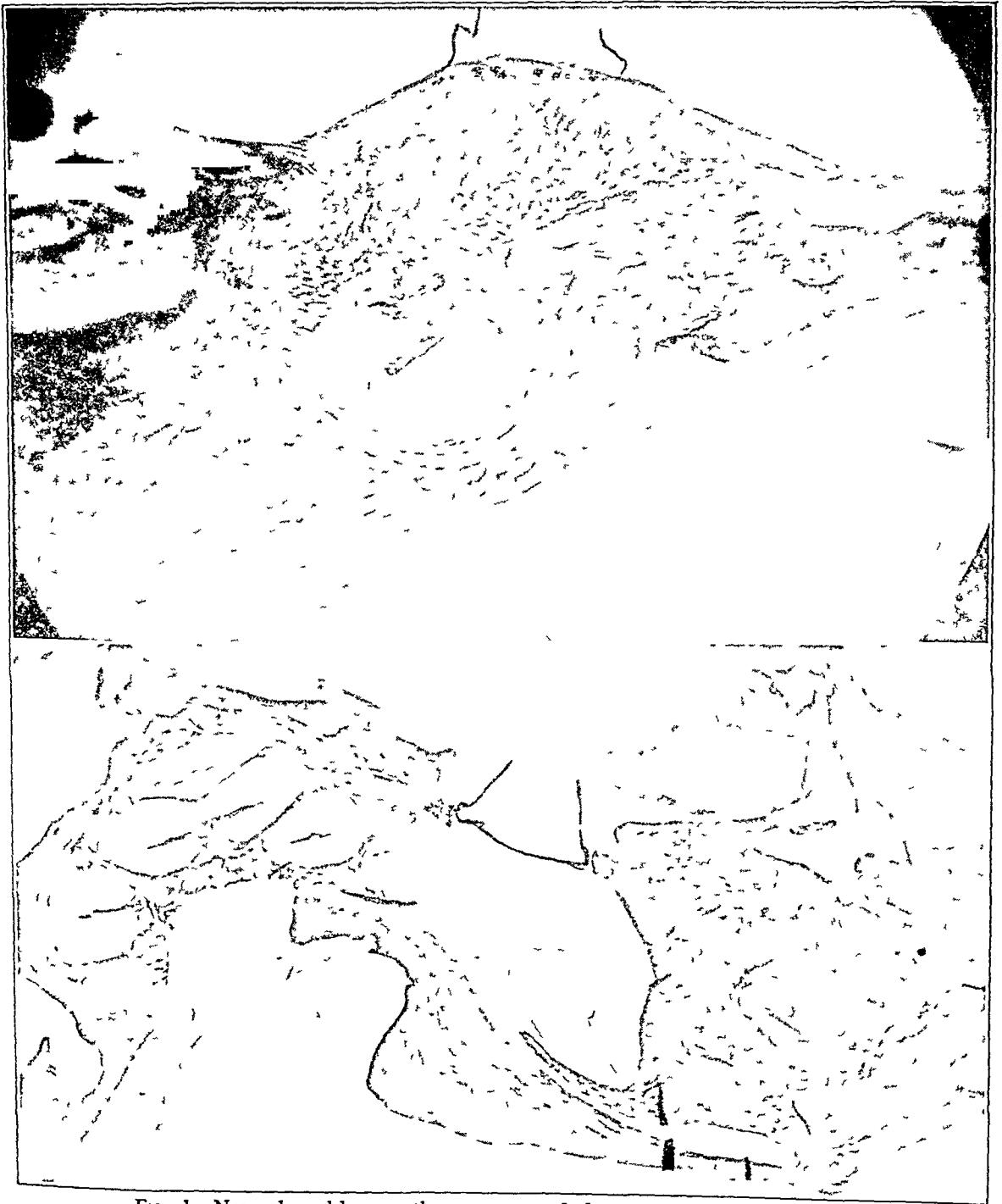


Fig 1—Normal cochlea in the presence of destruction of the crista of the semicircular canal and obliteration of the lumen of the lower part of the canal (as seen in the extreme right of the lower picture) following fenestration. Experiment II, monkey 24, right ear, eight months and two weeks after operation.



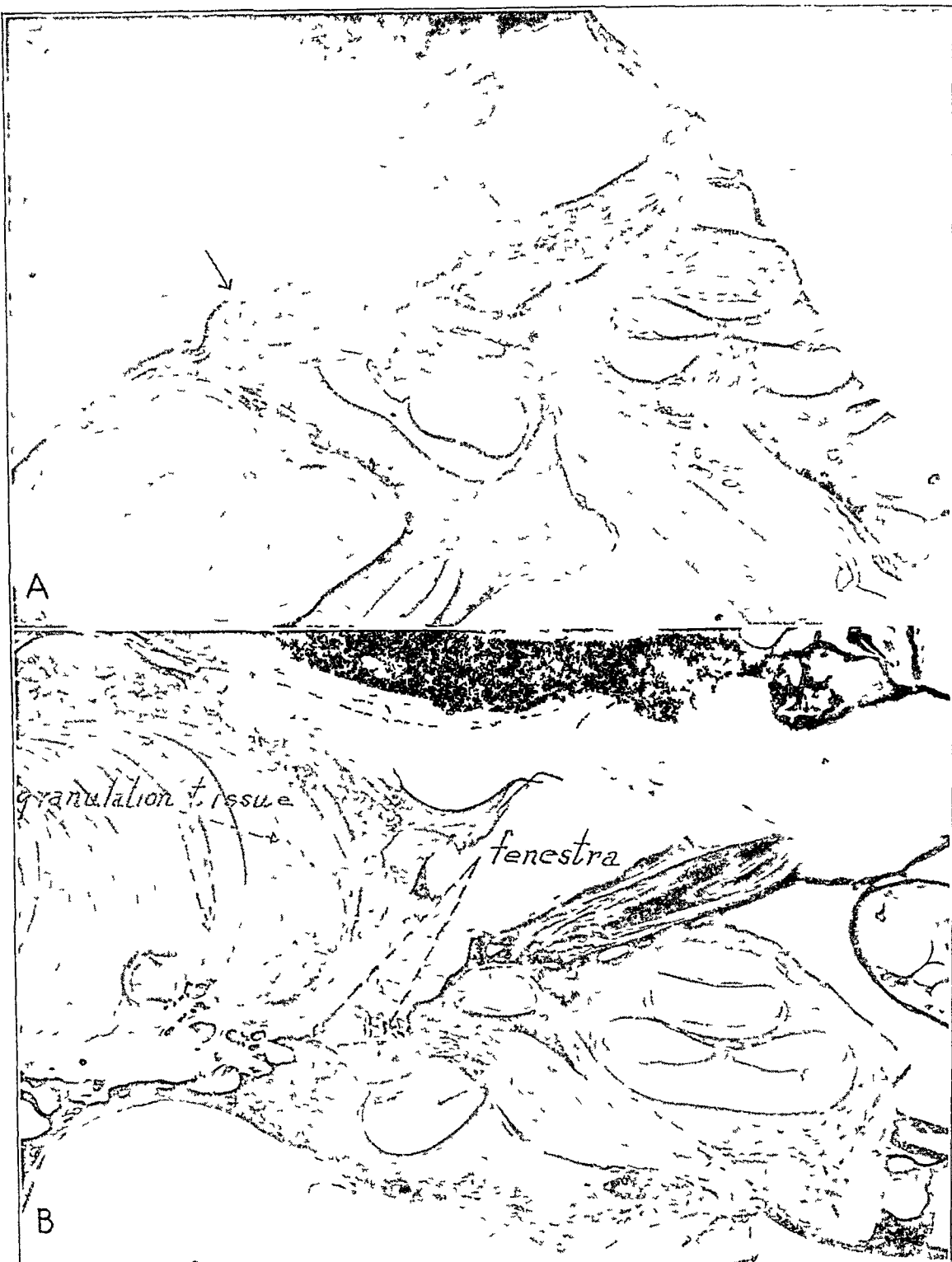


Fig 2—*A*, destruction of the crista of the horizontal canal by a large mass of mature bone lost within the perilymphatic space during fenestration. Note the normal cochlea with Reissner's membrane in situ and taut. The organ of Corti is in excellent state. Experiment I, monkey 15, left ear.

*B*, complete destruction of the crista of the horizontal canal with loosening of the perilymphatic tissue from the endosteal wall of the ampulla. A sagging of Reissner's membrane is the only pathologic change noted in the cochlea. Experiment I, monkey 11, left ear, six days after operation.



Fig 3—Fenestra in external semicircular canal closed as a result of periosteal bone regeneration. The membranous labyrinth and the endosteum were destroyed during fenestration. The cochlea remained in excellent condition. Monkey 59, right ear.

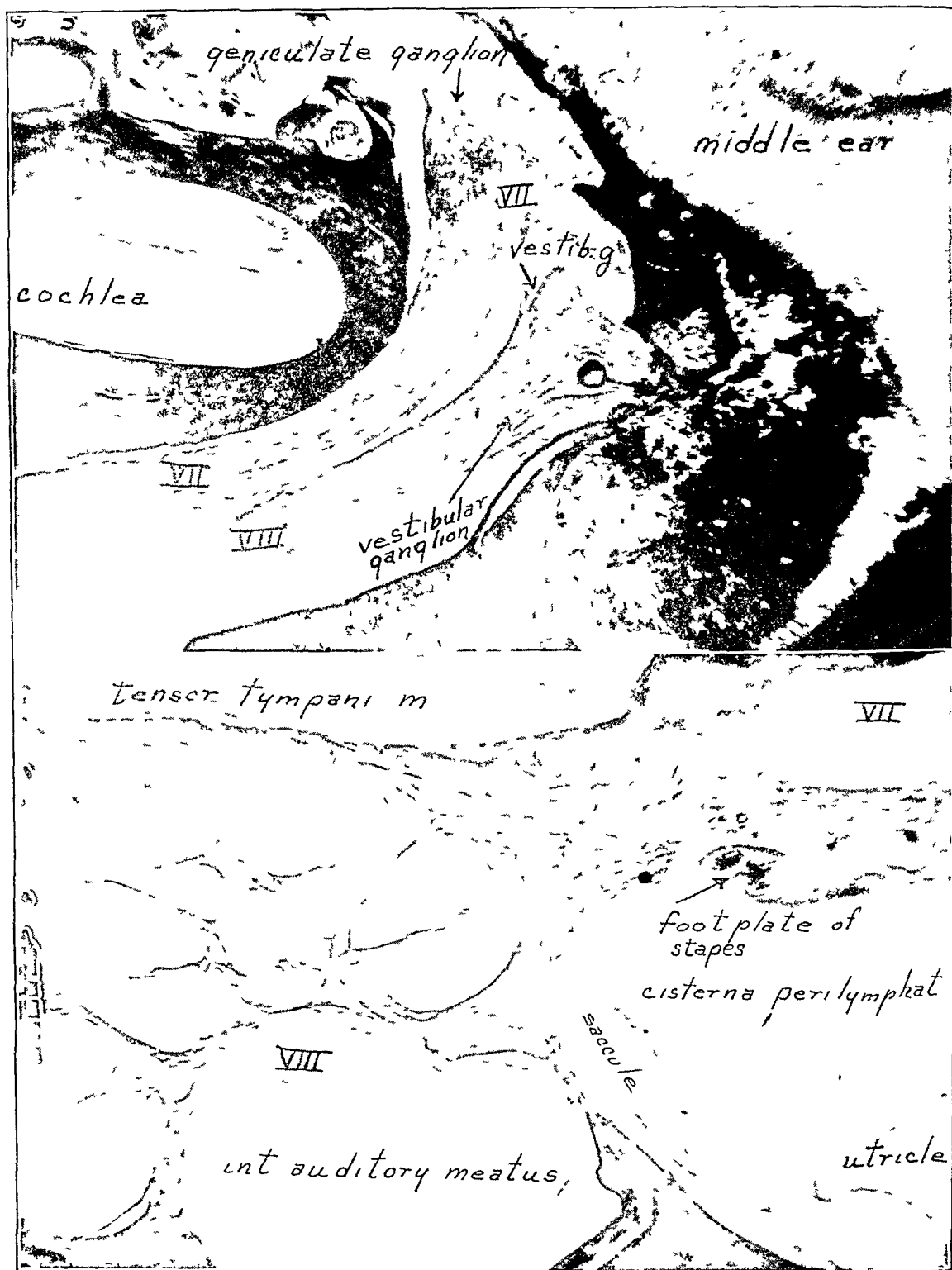


Fig 4—Complete destruction of the ampulla produced in the process of bur-  
nishing the walls of a fenestra with a silver amalgam. The cochlea is ap-  
parently normal. Experiment II, monkey 25, right ear, eight days after operation.

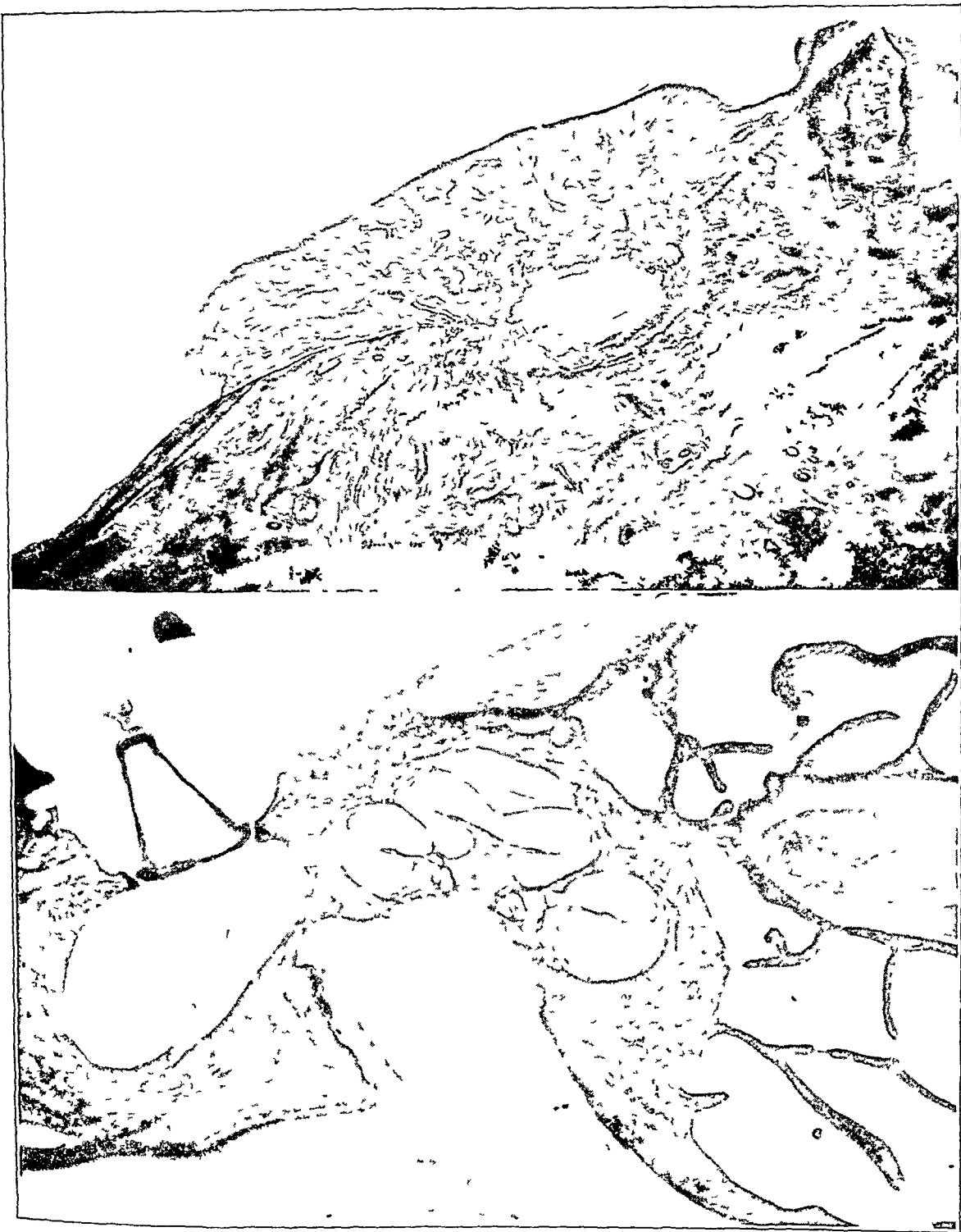


Fig 5—Obliteration of perilymphatic tissue by bone regenerating at the fenestra. The cochlea and the organ of Corti are apparently normal. Experiment II, monkey 29, left ear, seven months five days after operation.

bianous labyrinth does not result in degeneration of the remaining endolymphatic system

Only in rare instances in which infection of the labyrinth followed such a surgical procedure did degeneration of the entire endolymphatic labyrinth and of the organ of Corti take place. Such infection will also travel and involve the cochlear nerve trunk.

Figures 6 and 7 show photomicrographs of the degeneration of the endolymphatic systems of the experimentally fenestrated labyrinths of the rhesus monkey caused by infection following partial destruction of the vestibular portion of the endolymphatic labyrinth.

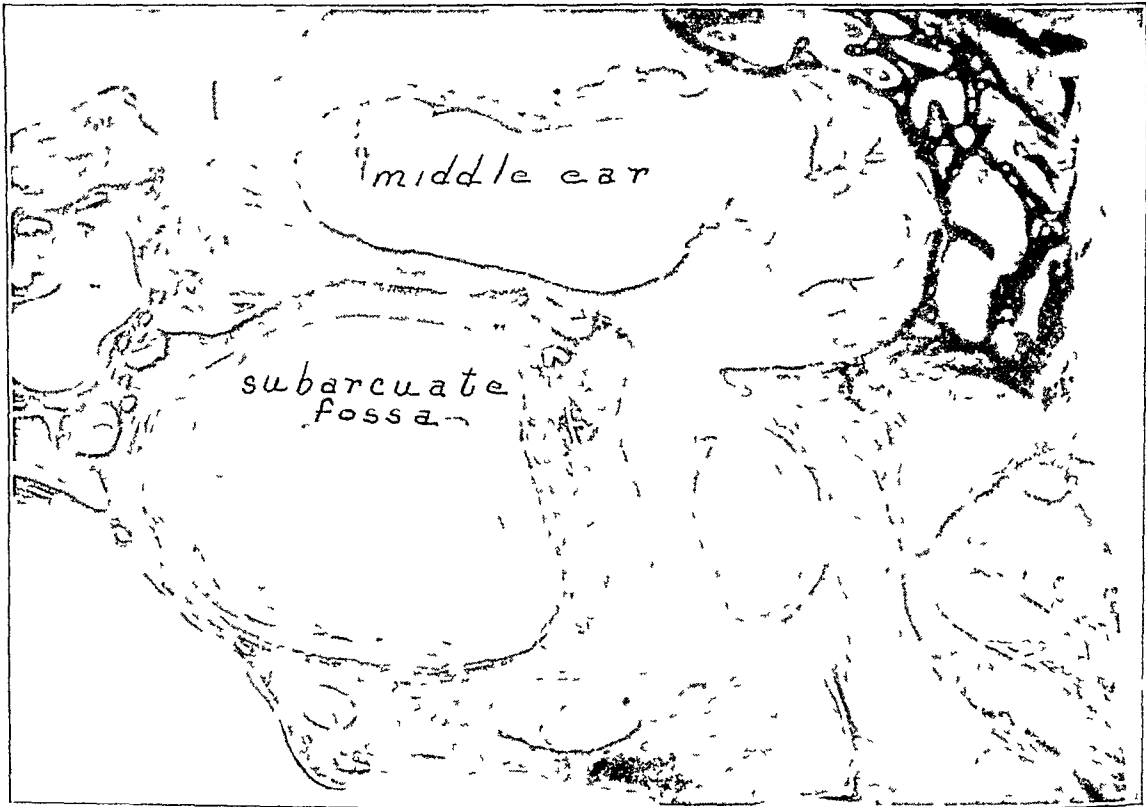


Fig 6—Otitis media with acute labyrinthitis in both vestibule and cochlea following fenestration. The organ of Corti shows degenerative changes. Experiment I, monkey 7, left ear, eight days after operation.

#### COMMENT

The aforementioned clinical and histologic observations led me to the following conclusions:

Partial destruction of the vestibular portion of the endolymphatic labyrinth is inadequate for the treatment of Ménière's disease. Since it does not as a rule result in degeneration of the cochlear part of the



Fig 7—Acute purulent labyrinthitis following fenestration in which mature bone was tossed within the fenestra. Regeneration is complete, and osteoid degeneration of the mature bone may be seen near the crista. Reissner's membrane, the organ of Corti and the tectorial membrane have been destroyed. Experiment 11B, monkey 20 left ear.

endolymphatic labyrinth and of the organ of Corti, it cannot be expected to relieve the tinnitus. The destruction of the most sensitive and most readily activated external semicircular canal will prevent the sensation of vertigo but will not necessarily prevent the recurrence of endolymphatic hydrops. When on occasion the endolymphatic labyrinth and the organ of Corti do degenerate after the partial destruction of the vestibular part of the endolymphatic labyrinth, they do so only as a result of postoperative infection. When the endolymphatic labyrinth degenerates as a result of postoperative infection, the tinnitus is not relieved and, moreover, is perpetuated by the cochlear neuritis which results from the extension of the inflammation from the organ of Corti to the cochlear nerve trunk.

Total loss of hearing for both air-conducted and bone-conducted sound following partial labyrinthectomy in Ménière's disease is no proof that the endolymphatic labyrinth and the organ of Corti have completely degenerated. Destruction of the utricle is sufficient to prevent the remaining endolymphatic system from being mobilized by sound to the degree necessary for the stimulation of the preoperatively partially damaged organ of Corti, which may have remained unchanged after the surgical intervention.

It therefore became obvious that any technic expected to relieve both the vestibular and the cochlear symptoms must supply a reasonable basis for belief that the entire endolymphatic labyrinth will degenerate as a result thereof and thus render the recurrence of endolymphatic hydrops impossible. Furthermore, the degeneration of the endolymphatic labyrinth when accomplished through the technic employed must not be the result of excessive postoperative inflammation or infection.

#### TECHNIC FOR EFFECTING ATRAUMATIC AND ASEPTIC DEGENERATION OF THE ENTIRE ENDOLYMPHATIC SYSTEM

**STEP 1 (a) *Creation of an Adequate Endaural Approach for Surgical Intervention Within the Tympanic Cavity*** (fig 8A) —Three incisions are made through the skin and periosteum lining the entire posterior wall of the external auditory canal. Incision 1 is begun at the inner margin of the superoposterior wall of the external auditory canal and carried outward along the superoposterior wall up to the apex of the membranous suprameatal triangle.

Incision 2 is begun at the inner margin of the inferoposterior wall of the external auditory canal and carried outward up to the lower end of the anterior border of the concha.

Incision 3 connects these two incisions in the posterior wall of the external auditory canal immediately adjacent to the posterior margin of the tympanic ring.

**(b) *Subperiosteal Elevation and Eversion of the Skin and Periosteum Lining the Posterior Wall of the External Auditory Canal*** (fig 8B and C) —With a narrow subperiosteal elevator placed within the third incision so that it hugs the posterior

bony wall of the external auditory canal, the skin and periosteum lining the posterior wall of the canal are elevated from within outward up to the anterior border of the concha and everted backward over the margin of the concha

With retractors inserted, the anterior margin of the outer mastoid cortex with spina Henle, the entire anterior mastoid cortex which forms the bony posterior wall of the external auditory canal, and the posterior aspect of the zygomatic process are exposed. The tympanic membrane is brought into view.

(c) *Widening of the External Auditory Canal* (fig 9) —The spina Henle is removed. The entire superposterior, posterior and inferoposterior bony walls of the external auditory canal and the posteroinferior border of the zygomatic process are shaved and skeletonized with a sharp cutting, electrically driven steel burr. Care should be exercised not to open any of the mastoid cell structure.

STEP 2 *Endaural Exposure of the Incudostapedial Joint and Round Window Niche* (fig 10) —(a) A narrow delicate periosteal elevator is placed against the skin free innermost margin of the posterior bony canal wall, immediately adjacent to the posterior margin of the tympanic membrane. With the elevator hugging the bony margin and directed inward toward the tympanic cavity, the posterior margin of the annulus fibrosus of the tympanic membrane is dislodged from its position within the sulcus tympanicus.

(b) With the same instrument, the posterior half of the tympanic membrane is everted and placed at rest over the anterior half of the tympanic membrane. The incudostapedial joint and the round window niche are thus exposed to view.

STEP 3 (a) *Decompression of the Vestibular Part of the Labyrinth* (figs 11, 12 and 13) —With a sharp 0000 Lempert curet, the tympanic ring in the region of the incudostapedial joint, which hides the crura of the stapes, is gently shaved to expose to direct view the entire crura of the stapes.

(b) With a sharp and narrow Lempert malleus clipper, the long process of the incus is cut near its attachment to the head of the stapedial crura, thus the stapes is freed from the incus.

(c) By engaging the crura of the stapes with a no. 11 or a no. 12 dental excavator and gently pulling the stapes in a direction anterior to and away from the oval window, one may easily remove the stapes with its crura and footplate intact. The vestibular perilymphatic space is thus widely opened, the perilymph drains out and the vestibular part of the endolymphatic labyrinth is exposed to the air of the tympanic cavity.

STEP 4 *Decompression of the Cochlear Part of the Labyrinth* (fig 14) —With an electrically driven 15 mm round polishing burr introduced into the round window niche, the membrane of the round window is removed and the round window properly enlarged. The perilymphatic space of the scala tympani is thus widely opened, the perilymph drains out and the cochlear part of the endolymphatic labyrinth is exposed to the air of the tympanic cavity.

STEP 5 *Sealing of the Tympanic Cavity with Tympanic Membrane* (fig 15) —The everted posterior half of the tympanic membrane is replaced in its original position. The dislodged posterior portion of the annulus fibrosus is fitted back into the sulcus tympanicus.

STEP 6 *Replacement of the Everted Membranous Lining of the Posterior Wall of the External Auditory Canal* —(a) The retractors are removed, and the everted skin and periosteum are replaced in position to line the posterior bony wall of the external auditory canal.

(b) The canal is packed with paraffin gauze to hold the skin and periosteum in position. This packing is removed on the seventh postoperative day. The patient leaves the hospital on the tenth postoperative day. Three hundred units of



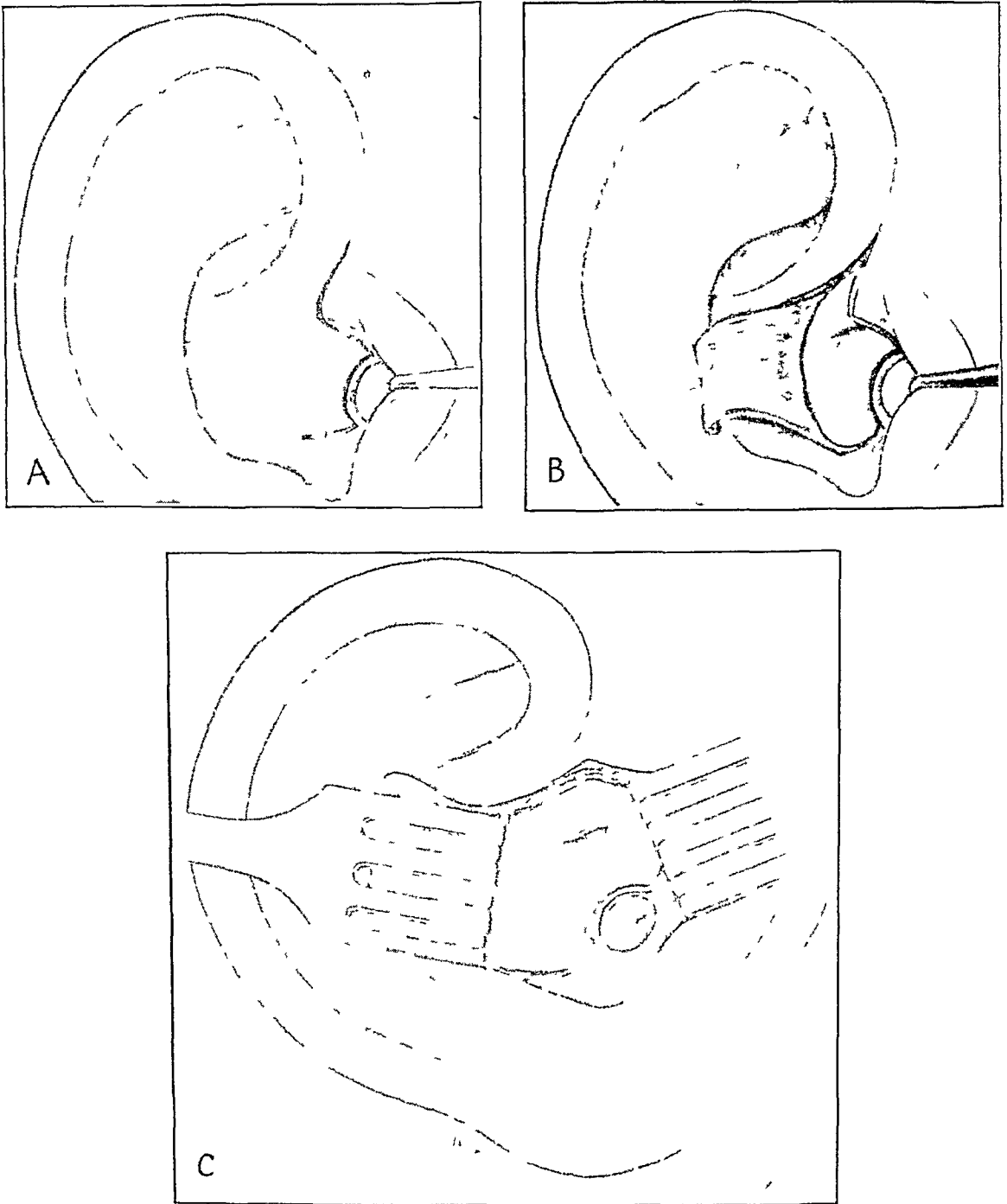


Fig 8—(A) Three endaural incisions are made through skin and periosteum (B) The skin flap is subperiosteally freed from its bony attachments and everted outward over the anterior margin of the concha (C) With retractors inserted, the outer mastoid cortex, the spina Henle, the entire anterior mastoid cortex and the tympanic membrane can now be seen

## LEMPERT-MÉNIÈRE'S DISEASE

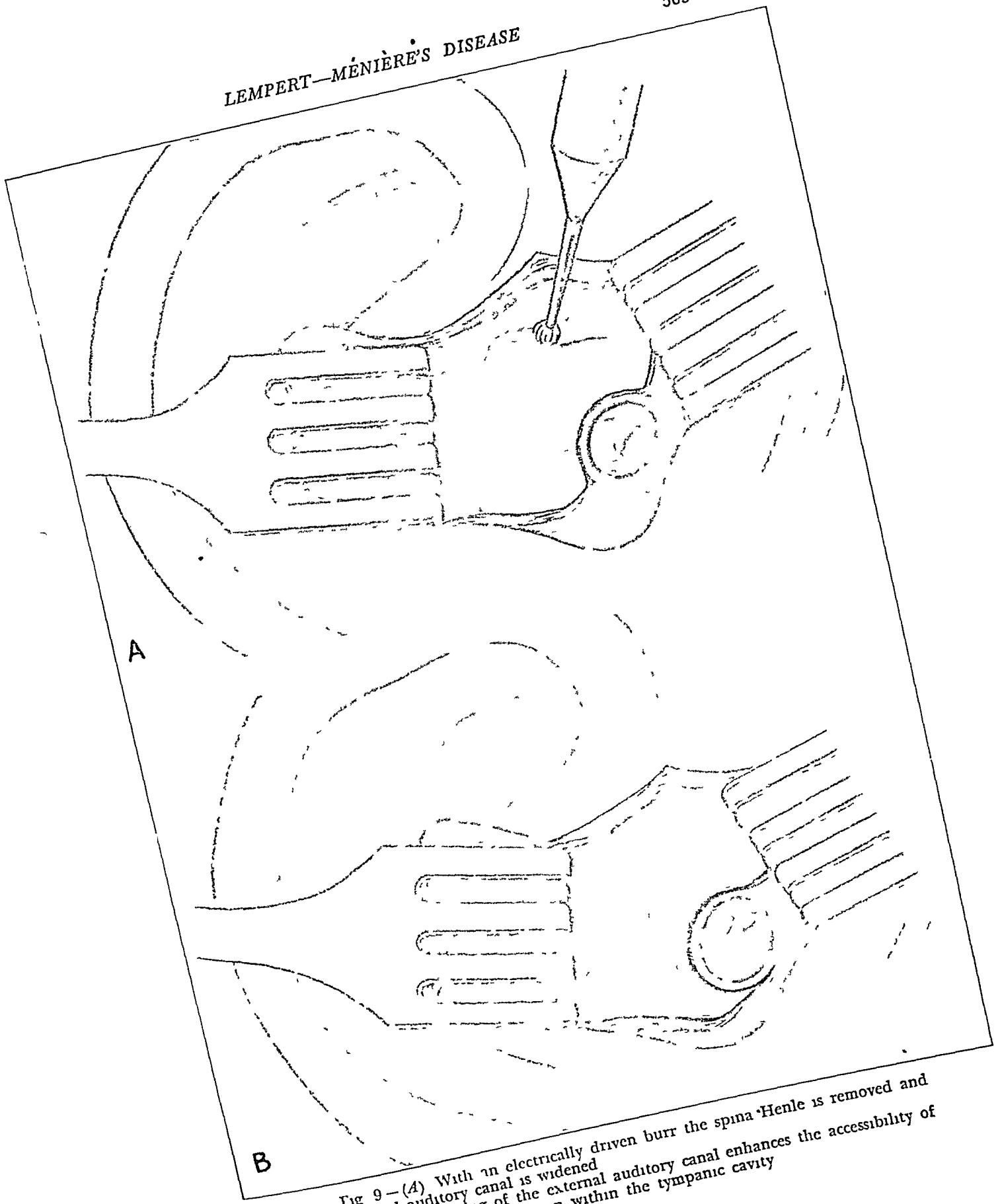


Fig 9—(A) With an electrically driven burr the spina Henle is removed and the external auditory canal is widened  
 (B) The widening of the external auditory canal enhances the accessibility of the field of surgical intervention within the tympanic cavity

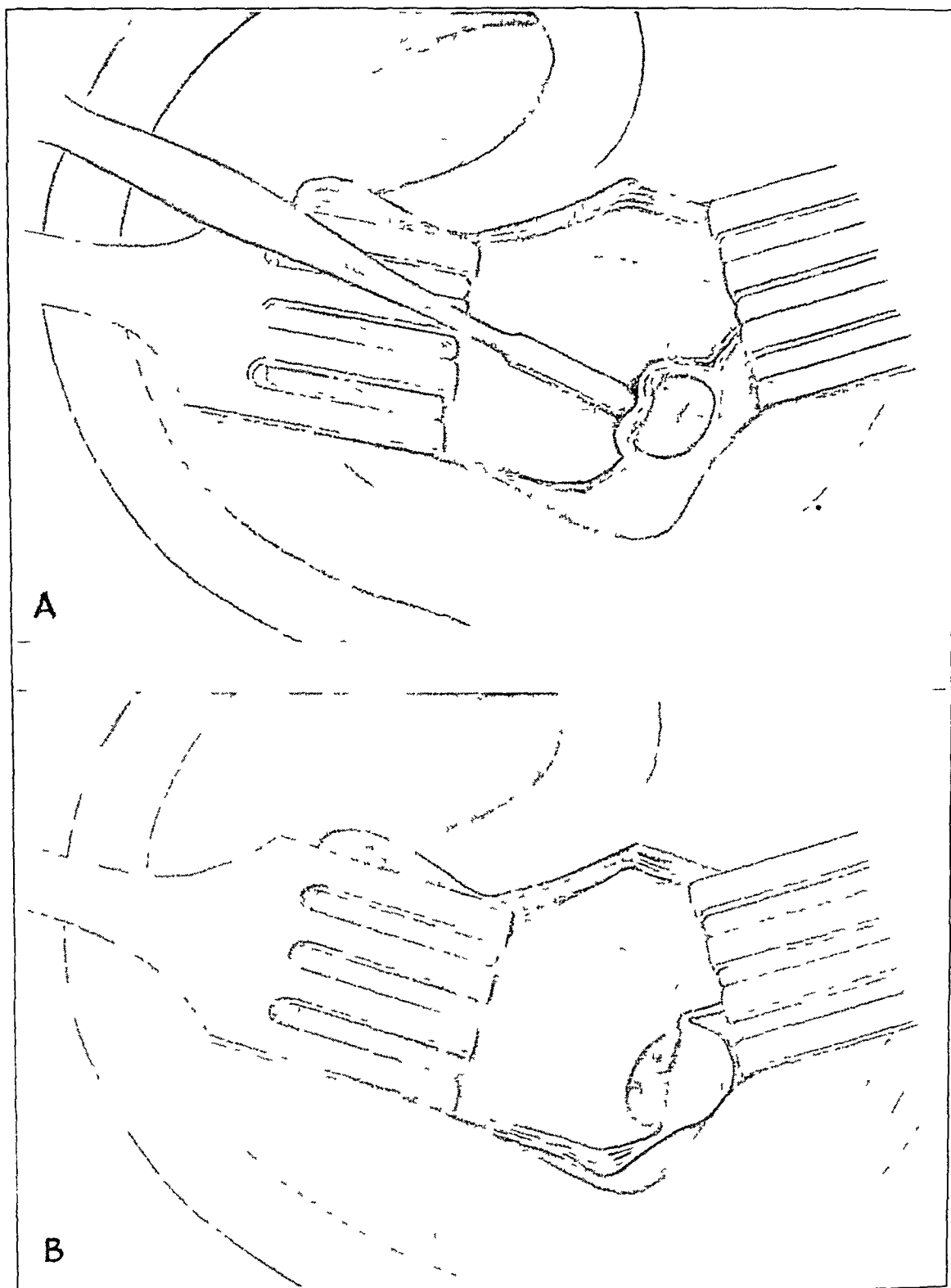


Fig 10 — (A) The annulus fibrosus of the posterior half of the tympanic membrane is dislodged from the sulcus tympanicus with a narrow periosteal elevator  
(B) The dislodged portion of the tympanic membrane is everted, exposing to view the incudostapedial joint and the niche of the round window

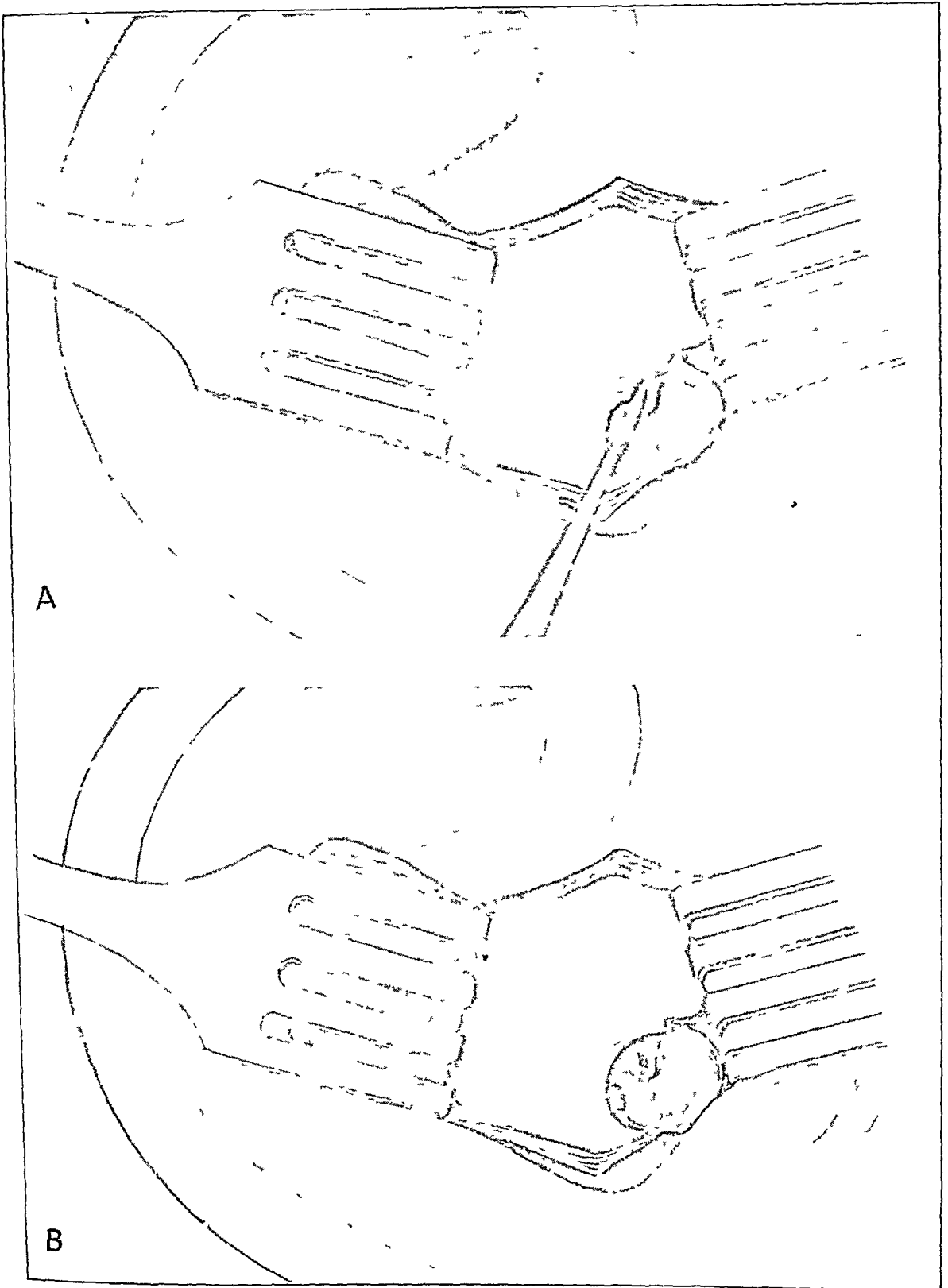


Fig 11 — (A) To expose the crura of the stapes, the portion of the bony annulus tympanicus which hides it is removed  
(B) The stapedial crura can now be seen

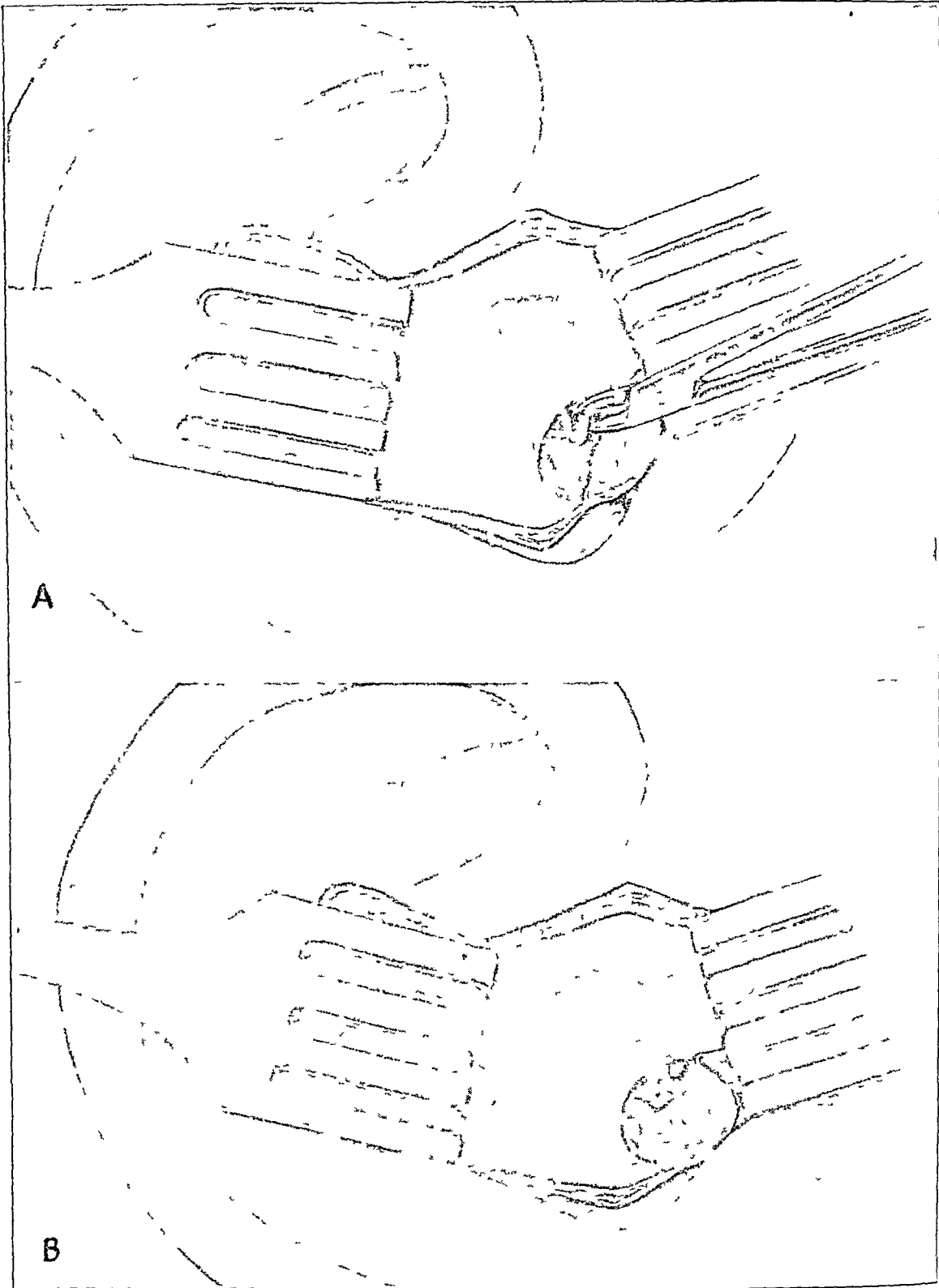


Fig 12 — (A) With a sharp, narrow steel clipper the long process of the incus is bisected close to its attachment to the head of the stapes  
(B) The bisected long process of the incus is seen

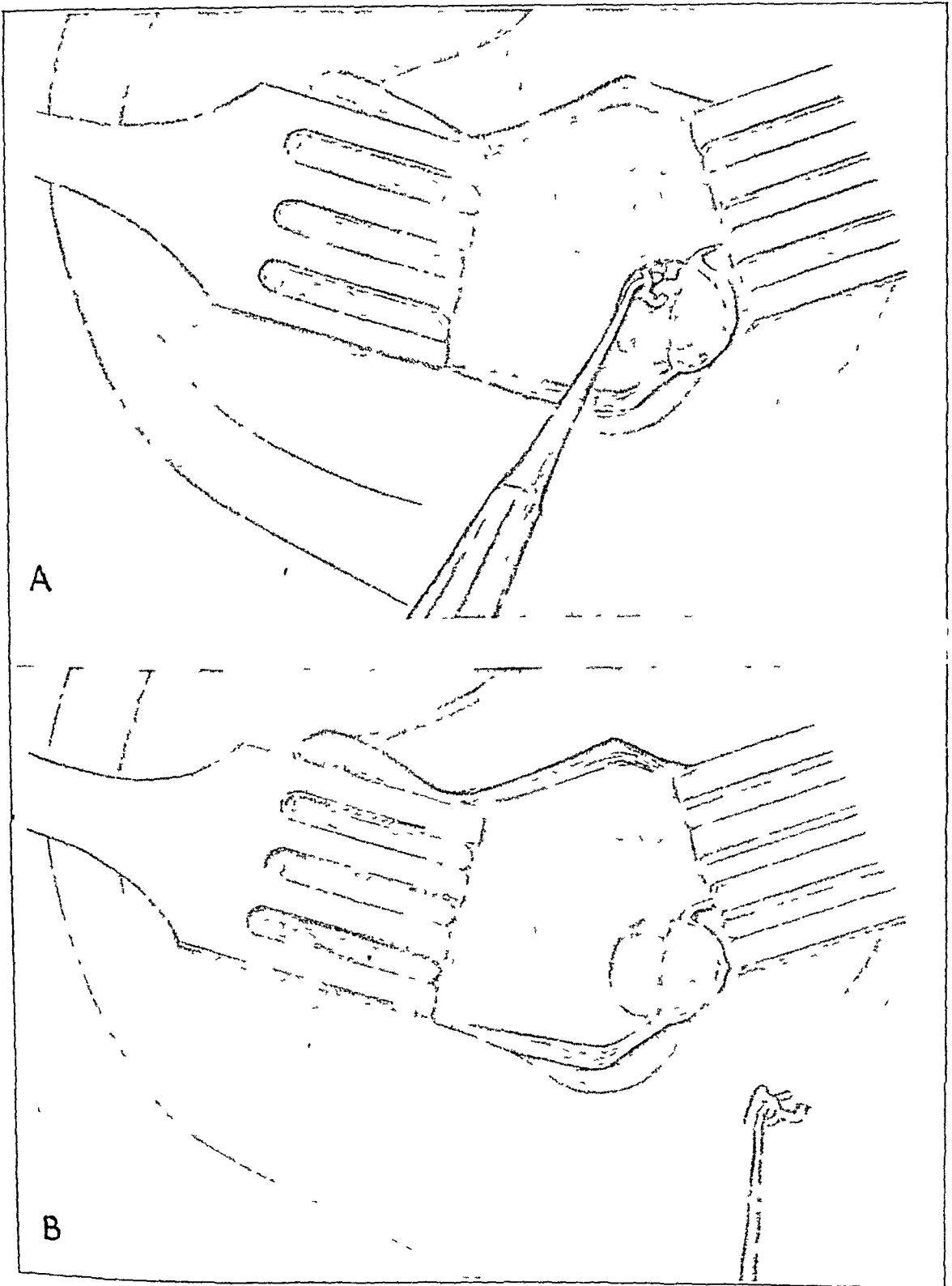


Fig 13—(A) The vestibular part of the labyrinth is decompressed by hooking and removing the stapes with its foot plate from the oval window  
(B) The disengaged stapes and the decompressed vestibule are seen

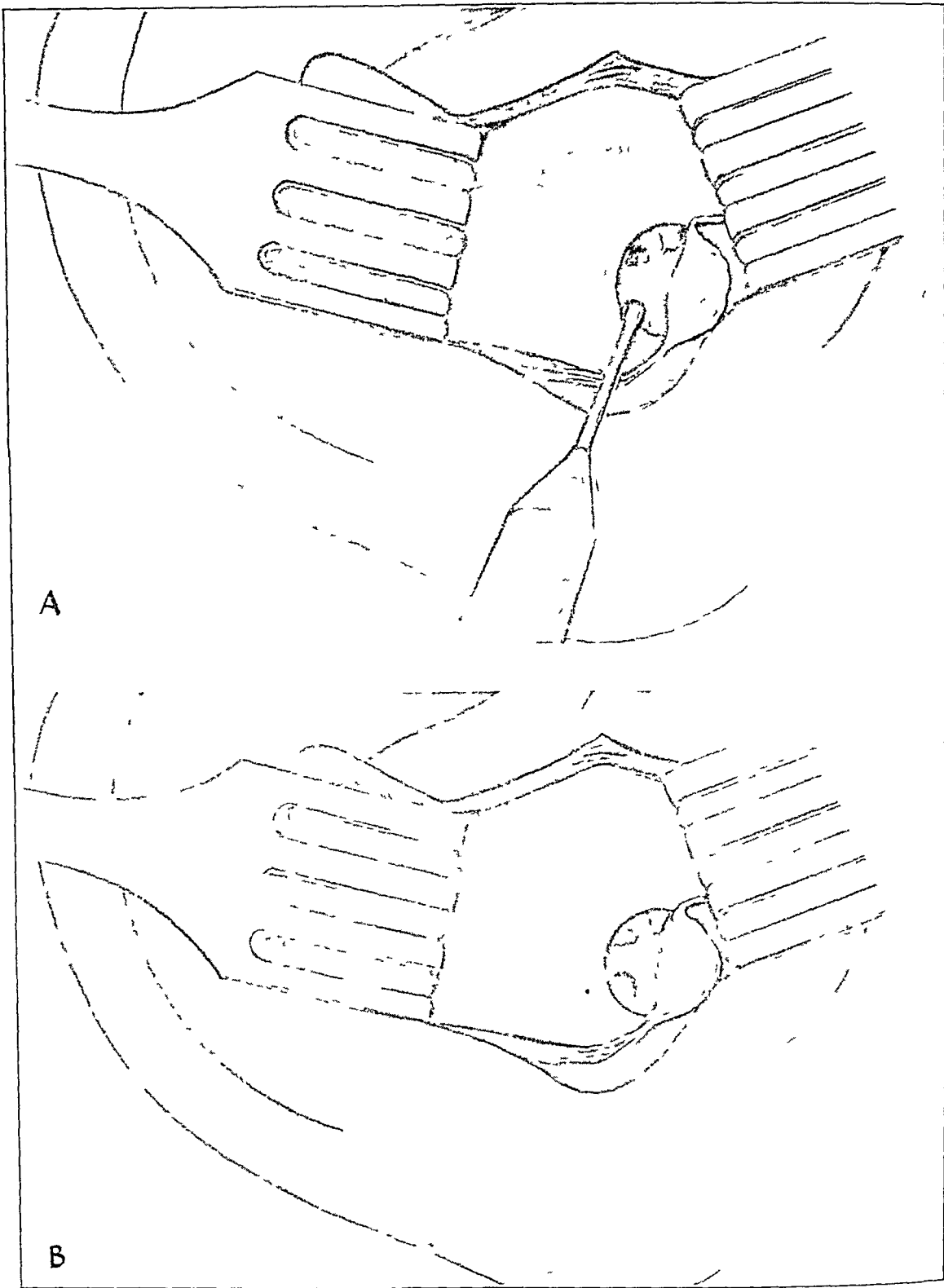


Fig 14 — (A) The oval window is seen, with the stapes removed. The cochlear part of the labyrinth is now decompressed by inserting an electrically driven 2 mm polishing burr into the round window niche and destroying the membrane of the round window.  
 (B) The decompressed vestibule and cochlea are now seen.

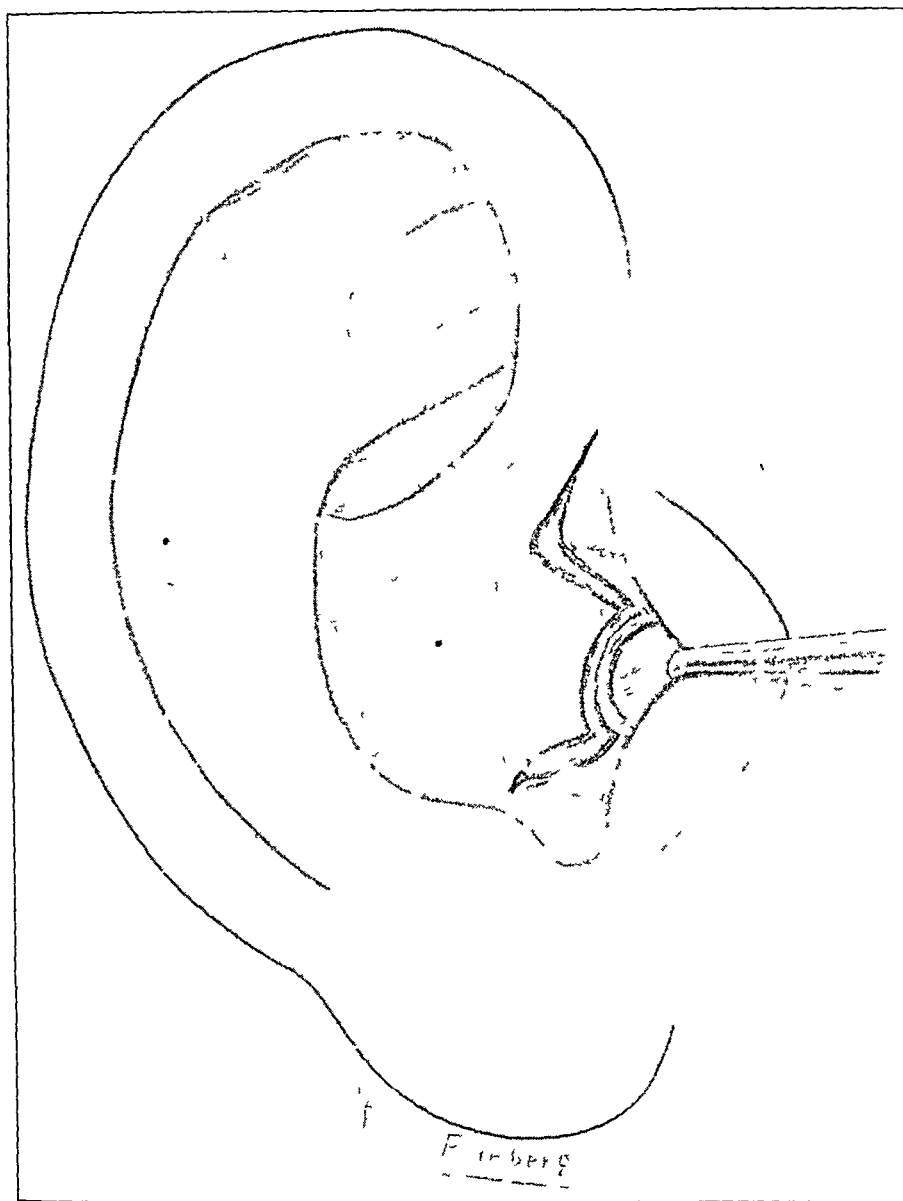


Fig 15—The dislodged portion of the tympanic membrane and the temporarily everted skin and periosteum of the external auditory canal are replaced to their original positions

penicillin is given daily during the entire hospital stay to reduce postoperative inflammation to an absolute minimum and to prevent postoperative infection

#### ADVANTAGES

1 The removal of the stapes and the round window membrane without traumatizing either the temporal bone or the endolymphatic labyrinth when executed under sterile precautions with the administration of penicillin results in aseptic degeneration of the entire endolymphatic labyrinth and of the organ of Corti



2 By effecting complete degeneration of the endolymphatic labyrinth the recurrence of endolymphatic hydrops can be definitely prevented

3 Such atraumatic aseptic degeneration of the endolymphatic labyrinth can result in the cure of both the vertigo and the tinnitus in Ménière's disease. Of the 10 patients who were operated on with this technic, 9 were freed from both vertigo and tinnitus. One was freed of vertigo but not of tinnitus, though the intensity of the tinnitus even in this case has greatly diminished.

4 Because the postoperative inflammatory reaction following this technic is of a minimal degree, the convalescence is much more rapid and attended by much less discomfort.

#### SUMMARY

A new technic for effecting atraumatic and aseptic degeneration of the endolymphatic labyrinth for the cure of both vertigo and tinnitus in Ménière's disease is described.

The clinical and histologic observations which have indicated the necessity for the development of such a technic are given.

The advantages which this technic offers are stated.

## THE BACTERIAL FLORA OF THE NASOPHARYNX IN RELATION TO THE COMMON COLD

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IT IS NOW the consensus that the primary cause of the infectious common cold is a filterable virus. This initial viral infection, however, is usually followed by secondary bacterial infections, of varying severity, which are generally regarded as being largely responsible for such complications of the disease as paranasal or accessory sinusitis, pharyngitis, laryngitis, tracheobronchitis, pneumonia and secondary infections of the lesions of pulmonary tuberculosis. Just how or why the primary viral infection predisposes to these important secondary bacterial infections is unknown, but it is commonly thought that the local resistance of the tissues is reduced by the virus. On the other hand, the concomitance of virus and different bacteria may be due to symbiotic infection, or it may be the result of an increase of the virulence of various streptococci, staphylococci, pneumococci and other micro-organisms commonly occurring in the upper respiratory tract or gaining access to it.

Be that as it may, the infectious common cold and the secondary bacterial infections constitute a disease of such economic and other importance that the causation, the prophylaxis and the treatment of this disease properly warrant deep interest and investigation. Needless to state, there is no hope of evolving a method of successfully immunizing or vaccinating against the disease until the virus has been cultivated for the preparation of vaccine, and this, unfortunately, has not yet been accomplished. Whether or not, however, autogenous and

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This investigation was aided in part by the William S. Merrell Company, Cincinnati.

From the Department of Bacteriology and Immunology of Temple University School of Medicine and the Research Institute of Cutaneous Medicine.

stock bacterial vaccines are of value in immunizing against the secondary bacterial infections is a subject of importance concerning which there continues to be a difference of opinion. Furthermore, the presently known sulfonamide and antibiotic compounds are ineffective against the virus, although some are effective in the treatment of the secondary bacterial infections, with special reference to sulfadiazine, sulfamerazine and penicillin.

#### PURPOSE OF INVESTIGATION

The purpose of our investigation was (1) to compare the nasopharyngeal bacterial flora of normal adults with that of adults who were suffering from the common cold, particularly the early and late stages of the disease, (2) to determine the relative incidence and quantitative importance of different micro-organisms in the nasopharyngeal cultures of those who showed secondary bacterial infections, (3) to determine the influence of season on the bacterial flora of the nasopharynx in normal persons and (4) to ascertain whether or not particular micro-organisms are responsible for the secondary infections. Needless to state, it is quite likely that the bacterial flora of normal adults, as well as that of adults subject to the common cold, may vary according to geographic factors, but it is likely that the results of this investigation may be generally applicable to the more northern localities of the United States at least.

#### TECHNIC EMPLOYED

With but few exceptions, all the normal subjects investigated and those with the common infectious cold were members of our staffs, medical students, laboratory technicians and nurses. Due care was exercised in excluding as far as possible persons with any chronic infection of the nasal accessory sinuses, including those with its complications, such as nasopharyngitis or laryngitis. Nasopharyngeal material was taken from both groups, and cultured, between November 1946 and May 1947, inclusive. During that period 1,132 cultures were made and studied, embracing 332 cultures of material taken from 209 normal adults and 800 cultures of material taken from 146 adults who had a total of 209 attacks of the common cold during the seven month period of investigation.

In isolating micro organisms from the upper nasopharynx, material was collected with bent sterile swabs (prepared of stiff nicochrome wire) without permitting it to become contaminated with any contents of the oral cavity. These swabs were placed in small tubes of sterile broth until plate cultures could be made, then two plates of tryptose blood agar (10 per cent sterile horse blood) were streaked in such manner as to permit the growth of isolated colonies readily adapted for identification. To aid in the identification of colonies, a small paper disk saturated with a solution of penicillin (15 units per cubic centimeter) was placed on each plate according to the technic of Bondi, Spaulding, Smith and Dietz<sup>1</sup>, this

1 Bondi, A., Jr., Spaulding, E. H., Smith, D. E., and Dietz, C. C. A Routine Method for the Rapid Determination of Susceptibility to Penicillin and Other Antibiotics, *Am J M Sc* **213** 221-226 (Feb) 1947.

procedure was particularly useful as an aid in the identification of *Hemophilus influenzae* and certain other micro organisms as well. One plate was incubated aerobically and the second anaerobically when the different bacteria were to be identified.

#### RESULTS OBSERVED

The micro-organisms found in cultures of the nasopharyngeal material taken from 198 normal controls and in 209 cases of the common cold are summarized in table 1 after a method similar to that employed by Julianelle and Siegel.<sup>2</sup> It will be observed that the same micro organisms were isolated from the adults with the common cold

TABLE 1—Incidence of Each Variety of Micro Organisms in Nasopharynxes of Normal Adults and Adults with the Common Cold

Variety	Percentage from Which the Given Variety Was Isolated*	
	Normal Controls	Cases of the Common Cold
<i>Streptococcus alpha</i>	23.4	22.7
<i>Streptococcus beta</i> (group A)	1.8	4.0
<i>Streptococcus beta</i> (other types)	20.1	18.8
<i>Streptococcus gamma</i>	13.6	13.8
<i>Staphylococcus albus</i>	3.1	3.7
<i>Staphylococcus aureus</i>	3.8	5.8
<i>Hemophilus influenzae</i>	0.4	0.7
<i>Neisseriae</i>	24.8	22.3
Pneumococci	3.5	3.2
Diphtheroid bacilli	4.0	3.4
Miscellaneous varieties†	1.4	1.1

\*The percentage is based on 198 normal controls and 209 cases of the common cold.

†These included *Pseudomonas pyocyanea* (*Ps. aeruginosa*), *Klebsiella pneumoniae* and yeasts.

as from the normal adults, in no instance was an unusual bacterium found in the cultures of the persons suffering from the common cold. In these persons, however, the incidence of beta hemolytic streptococci of group A and staphylococci was slightly but definitely higher than in the normal controls, along with a slightly increased incidence of *H. influenzae*. At the same time it will be observed that the incidence of the *Neisseriae*, with special reference to *N. catarrhalis*, was slightly lower in patients with the common cold than in normal controls, an observation which indicates that *Neisseria* infection may not be as important in the common cold as is generally surmised. Furthermore, the incidence of pneumococci was essentially the same in the naso-

2 Julianelle, L. A., and Siegel, M. The Epidemiology of Acute Respiratory Infections Conditioned by Sulfonamides. II. Gross Alterations in the Nasopharyngeal Flora Associated with Treatment, *Ann. Int. Med.* **22**: 10-20 (Jan.) 1945.

pharyngeal cultures of both series of persons although, as shortly to be discussed, multiple cultures of patients with the common cold have shown a definite increase of pneumococci as compared with multiple cultures of normal controls

These comparative differences are shown more definitely in table 2, in which the percentage of the isolations of each of the various micro organisms is based on 332 cultures of 198 normal controls and 800 cultures obtained in 209 cases of the common cold. For some persons, as many as 10 to 15 cultures were made. Consequently, the data summarized in this manner must be broadly interpreted, because

TABLE 2—*Incidence of Each Variety of Bacteria in Nasopharyngeal Cultures of Normal Adults and Adults with the Common Cold*

Variety	Percentage of Cultures Showing Given Variety	
	Normal Controls*	Cases of the Common Cold†
<i>Streptococcus alpha</i>	84.3	83.9
<i>Streptococcus beta</i> (group A)	6.6	14.8
<i>Streptococcus beta</i> (other types)	72.3	69.4
<i>Streptococcus gamma</i>	49.1	51.0
<i>Staphylococcus albus</i>	11.1	13.5
<i>Staphylococcus aureus</i>	13.6	21.5
<i>Hemophilus influenzae</i>	1.5	2.8
<i>Neisseriae</i>	89.5	82.4
<i>Pneumococci</i>	12.7	11.9
<i>Diphtheroid bacilli</i>	14.5	12.6
Miscellaneous varieties‡	5.1	4.1

\*The percentage is based on 332 cultures of nasopharyngeal material taken from 198 normal controls

†The percentage is based on 800 cultures of nasopharyngeal material obtained in 209 cases of the common cold

‡These include *Pseudomonas pyocyanea*, *Klebsiella pneumoniae* and yeasts

the percentage incidence of any particular micro organism occurring in all cultures of a given person would be increased according to the number of cultures made and examined. To determine whether or not this is the case, further data were assembled in table 3, in which the percentage of isolations is based on the "average culture" of each person. This average culture represented the various bacteria isolated in 50 per cent or more of all the cultures made on a given person. The incidence of the various micro-organisms appearing in 94 average or representative cultures of 94 persons each of whom had a single cold is shown. For comparison, data are summarized with regard to a group of normal controls in whose interest multiple cultures had been made. The results tabulated in this manner, however, have like-

wise shown an increase of beta hemolytic streptococci of group A, *Staphylococcus aureus* and pneumococci in cases of the common cold

As shown in table 4, the percentage of subjects whose cultures showed coagulase-positive staphylococci was practically the same in the group with the common cold (54.6 per cent) as in the group of normal controls (54.9 per cent)

TABLE 3—Average Percentage of Isolations of Each Variety of Bacteria Found in Nasopharyngeal Cultures of Normal Adults and Adults with the Common Cold

Variety	Average Percentage of Isolations	
	Normal Adults*	Adults with the Common Cold†
<i>Streptococcus</i> , alpha	22.9	23.1
<i>Streptococcus</i> , beta (group A)	1.0	3.3
<i>Streptococcus</i> , beta (other types)	22.4	20.6
<i>Streptococcus</i> , gamma	15.7	15.1
<i>Staphylococcus albus</i>	4.3	1.6
<i>Staphylococcus aureus</i>	3.8	4.9
<i>Hemophilus influenzae</i>	1.0	0.5
<i>Neisseriae</i>	23.8	24.5
Pneumococci	2.9	3.3
Diphtheroid bacilli	2.4	3.0

\*The percentage is based on the "average culture" of 50 normal controls (average of 3.9 cultures per person)

†The percentage is the "average culture" of 94 adults with the common cold (average of 7.7 cultures per person)

TABLE 4—Coagulase Activity of *Staphylococci* Isolated, in Nasopharyngeal Cultures, from Normal Adults and Adults with the Common Cold

Group	Number	Percentage Whose <i>Staphylococci</i> Were Coagulase Positive	Percentage Whose <i>Staphylococci</i> Were Coagulase Negative
Normal adults	51	54.9	45.1
Adults with colds	185	54.6	45.4

The specific serologic types of the pneumococci isolated in the 28 cultures of pneumococci of the 198 normal controls and in the 41 cultures of pneumococci obtained in 209 cases of the common cold were also determined, the results being summarized in table 5. In the cultures representing the normal controls, 13 different types were identified, with 2 cultures in which the type or types could not be determined. In the cultures representing cases of the common cold, 15 different types were identified, with 2 cultures in which the type or types could be determined. It will be observed that types I and II

were conspicuous by their absence, type I was found only once in the cultures made in cases of common cold, while types III, VI, X, XI and XIX occurred most frequently, especially type VI

TABLE 5—Incidence of Each Specific Type of *Pneumococci* in Nasopharyngeal Cultures of Normal Adults and Adults with the Common Cold

Group	Number of Cultures of <i>Pneumococci</i>	NUMBER OF CULTURES SHOWING GIVEN TYPE OF PNEUMOCOCCI																		
		I	III	VI	VII	VIII	IX	X	XI	XIV	XV	XVIII	XIX	XX	XXII	XXIII	XXIV	XXVIII	XXIX	*
Normal adults	28	0	4	5	0	0	1	1	1	0	1	1	2	1	0	2	3	3	1	2
Adults with cold	41	1	4	8	2	1	1	4	4	1	0	0	5	0	1	2	1	3	1	2

\*The type could not be identified

TABLE 6—Quantitative Estimation of the Growth of Each Variety of Micro Organisms Found in Nasopharyngeal Cultures of Normal Adults and Adults with the Common Cold\*

Variety	Percentage of Cultures Showing Given Amount of Growth†							
	Normal Controls				Cases of the Common Cold			
	+	++	+++	++++	+	++	+++	++++
<i>Streptococcus alpha</i>	9	35	37	19	11	31	33	25
<i>Streptococcus beta</i> (group A)	55	9	23	14	55	23	13	9
<i>Streptococcus beta</i> (other types)	39	34	20	7	47	29	15	9
<i>Streptococcus gamma</i>	47	40	10	3	46	44	9	1
<i>Staphylococcus albus</i>	57	19	13	11	53	25	6	16
<i>Staphylococcus aureus</i>	49	18	15	18	51	27	11	11
<i>Hemophilus influenzae</i>	20	60	20	0	9	27	32	32
<i>Neisseriae</i>	17	37	28	18	14	34	31	21
<i>Pneumococci</i>	17	30	17	36	17	26	28 5	28 5
<i>Diphtheroid bacilli</i>	73	23	4	0	65	30	5	0
Miscellaneous varieties‡	53	6	23	18	34	34	23	9

\*The total numbers on which this table is based are 198 normal adults (332 cultures) and 209 cases of the common cold (800 cultures)

†The amount of growth is indicated as follows + (occasional colony), ++ (few colonies), +++ (moderate number of colonies) and ++++ (many colonies)

‡These include *Pseudomonas pyocyanea*, *Klebsiella pneumoniae* and yeasts

An attempt was made to measure quantitatively the number of colonies of the different micro-organisms on the plates of tryptose blood agar. The results, based on 332 cultures of 198 normal controls and 800 cultures made in 209 cases of common cold, are summarized.

in table 6, in which the percentages of cultures of each of various micro-organisms showing 1,2,3, and 4 plus growths, respectively, are shown. It will be observed that the beta hemolytic streptococci, staphylococci, pneumococci and H influenzae were numerically more numerous in cultures in the cases of the common cold than in cultures of normal controls.

Of additional interest are the results of 89 cultures made in 39 cases of the common cold during the early stage (first four days) and 132 cultures made in the same cases during the late (after the fourth day) stage of the disease. These results are summarized in table 7, in which it will be observed that the percentages of positive cultures of

TABLE 7—Incidence of Each Variety of Bacteria in Nasopharyngeal Cultures Which Were Made in 39 Cases of the Common Cold Taken During the Early and the Late Stage of the Disease

Variety	Percentage Incidence	
	Early Stage*	Late Stage†
Streptococcus alpha	87.6	86.4
Streptococcus beta (group A)	14.6	15.2
Streptococcus beta (other types)	62.9	68.2
Streptococcus gamma	56.2	56.8
Staphylococcus albus	9.0	12.1
Staphylococcus aureus	16.9	17.4
Hemophilus influenzae	2.2	2.3
Neisseriae	79.8	80.3
Pneumococci	7.9	11.4
Diphtheroid bacilli	13.5	11.4

\*The incidence is based on 89 cultures made during the first four days.

†The percentage is based on 132 cultures made after the fourth day.

beta hemolytic streptococci, staphylococci and pneumococci were somewhat higher during the late than during the early stage of the common cold. On the quantitative basis, beta hemolytic streptococci (especially group A), Staph aureus and pneumococci were also more numerous during the late than during the early stage of the disease, as shown in table 8.

As expected, seasons have had some influence on the bacterial flora of the nasopharynx in normal persons in Philadelphia. As shown in table 9, based on the results of single cultures of material taken from 204 adults, gamma streptococci, staphylococci, pneumococci, H influenzae and diphtheroid bacilli occurred somewhat more frequently during the autumn and winter months (November to March, inclusive) than during the spring months (April and May). Curiously



enough, however, beta hemolytic streptococci (including group A) and the Neisseriae were found somewhat more frequently during April and May

TABLE 8—*Quantitative Estimation of the Growth of Each Variety of Organisms Present in Nasopharyngeal Cultures in 39 Cases of the Common Cold Taken During the Early and the Late Stage of the Disease\**

Organisms	Percentage of Cultures Showing Given Amount of Growth†							
	Early Stage (89 Cultures)				Late Stage (132 Cultures)			
	+	++	+++	++++	+	++	+++	++++
Streptococcus, alpha	8	28	32	32	11	27	44	18
Streptococcus beta (group A)	46	39	15	0	45	30	20	5
Streptococcus, beta (other types)	48	27	9	16	52	27	12	9
Streptococcus gamma	34	56	8	2	51	40	9	0
Staphylococcus albus	75	12 5	0	12 5	63	31	0	6
Staphylococcus aureus	67	20	6 5	6 5	35	39	13	13
Neisseriae	17	24	29 5	29 5	14	35	26	25
Pneumococci	14	43	14	29	13	7	47	33
Diphtheroid bacilli	75	17	8	0	40	53	7	0

\*The early stage is that observed during the first four days, the late stage that after the first four days

†The amount of growth is indicated as follows + (occasional colony), ++ (few colonies) +++ (moderate number of colonies), ++++ (many colonies)

TABLE 9—*Seasonal Influence on the Incidence of Each Variety of Bacteria Observed in Nasopharyngeal Cultures of Normal Adults*

Variety of Organisms	Percentage of Positive Cultures in Given Period	
	November—March*	April—May†
Streptococcus alpha	23 7	24 1
Streptococcus beta (group A)	1 4	2 7
Streptococcus beta (other types)	18 1	22 0
Streptococcus gamma	15 8	12 3
Staphylococcus albus	3 4	2 7
Staphylococcus aureus	4 5	2 4
Hemophilus influenzae	1 1	0
Neisseriae	22 0	26 3
Pneumococci	3 1	2 7
Diphtheroid bacilli	5 4	4 3
Miscellaneous varieties‡	1 4	0 5

\*The percentage is based on the results of 100 cultures of nasopharyngeal material taken from 100 adults

†The percentage is based on the results of 104 cultures of nasopharyngeal material taken from 104 adults

‡These include *Pseudomonas pyocyanea*, *Klebsiella pneumoniae* and yeasts

## COMMENT

The results of this investigation indicate, therefore, that beta hemolytic streptococci of group A, staphylococci and pneumococci are important in the causation of the secondary bacterial infections associated with the common cold. Of these, beta hemolytic streptococci of group A and staphylococci appear to be of most importance. But while a large percentage of cases of pneumococcic pneumonia are known to follow antecedent infections of the upper respiratory tract, including the common cold, and while 50 to 60 per cent of cases are due to infections with pneumococci of types I and II, yet these two types were conspicuous by their absence in this investigation. Under the circumstances it appears that the role played by the common cold in the causation of pneumonia of types I and II, at least, may be largely that of reducing the local resistance of the lower respiratory tract and thus favoring infection with pneumococci that gain access to the tract through the patient's coming in contact with carriers.

It is not our purpose at the present time, however, to discuss the manner in which the results observed relate to methods of immunizing or vaccinating against the secondary bacterial infections of the common cold. In this connection it may be briefly stated, however, that Kolmer<sup>3</sup> has found that the parenteral administration of carefully prepared vaccines has apparently proved of prophylactic value in a large percentage of persons who do not have pronounced chronic infection of the nasal accessory sinuses and especially chronic ethmoidal infection. In chronic sinusitis acute exacerbations or relapses of the disease are commonly and erroneously regarded as attacks of the infectious common cold. If vaccines are employed for active immunization, it appears that they should be prepared of beta hemolytic and gamma streptococci, *Staph aureus* and *H influenzae* with special reference to beta hemolytic streptococci of group A. Obviously, it is impossible to include adequate numbers of all the specific types of pneumococci, but, if any are included, it would appear advisable to employ types III, VI, X, XI and XIX so far as the results of this investigation are concerned.

## SUMMARY AND CONCLUSIONS

Various micro-organisms were identified in 1,132 cultures of material swabbed from the upper nasopharynxes of 209 normal adults (332 cultures) and 146 adults who had a total of 209 attacks of the common cold (800 cultures) during the period of investigation.

<sup>3</sup> Kolmer, J. A. *Chemotherapy and Biotherapy: Their Relation to the Prevention and Treatment of Diseases of the Ear, Nose and Throat*, Arch. Otolaryng. 40: 17-28 (July) 1944.

All microorganisms isolated from adults suffering with the common cold were likewise isolated from normal adults

Beta hemolytic streptococci of group A, staphylococci and pneumococci, however, occurred more frequently and in larger numbers in the cultures made in the cases of the common cold than in the cultures of material taken from the normal controls, apparently these microorganisms are important in the causation of the secondary bacterial infections associated with the common cold and its complications

Beta hemolytic streptococci of group A, staphylococci and pneumococci also occurred more frequently and in larger numbers in the late than in the early stages of the common cold

Gamma streptococci, staphylococci, pneumococci, H influenzae and diphtheroid bacilli occurred more frequently in cultures of material from normal adults during the autumn and winter months than during the spring months, beta hemolytic streptococci and the Neisseriae occurred more frequently during the spring than during the winter months

The incidence of coagulase-positive staphylococci was practically the same in cultures made in cases of the common cold as in cultures of material from normal controls

Thirteen different types of pneumococci were observed in cultures of material from normal controls and fifteen different types in cultures made in cases of the common cold. In cultures representing cases of the common cold, types III, VI, X, XI and XIX occurred most frequently, especially type VI

These results are briefly discussed in relation to the possibility of actively immunizing persons against the secondary bacterial infections of the common cold

## CHOLESTEATOMA AND CHRONIC OTITIS

### Etiologic Problems

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THE TERM "CHOLESTEATOMA" dates from the beginning of the nineteenth century, created by the anatomist J. Miller, with the implication that the lesion should be regarded as a genuine tumor. According to the pathologists Cruveilhier, Rokitsansky and Virchow, cholesteatoma often occurs in the ear but rarely at other places in the skull—for example, in the pia mater or the os petrosum. They did not, however, discard the view that cholesteatoma, even when occurring in the ear, is a genuine tumor. The otologists Gruber (1862) and von Troltsch (1868) showed that in clinical treatment chronic otitis is frequently found in conjunction with cholesteatoma. They contended that cholesteatoma of the ear—in distinction from that of the pia mater—is not a real tumor and that it is caused by chronic otitis. Brock considered this view to be *naheliegend und einleuchtend* (reasonable and enlightening). It seems to be generally accepted to this day.<sup>1</sup>

In clinical practice one often finds oneself confronted with recurring combinations of two or more pathologic phenomena, each of which may manifest itself independently. In certain cases the co-existence may be quite fortuitous, in others it may be due to a real connection. The phenomena may be connected simply as parallel effects of a common cause, or they may be really related as cause and effect. In the latter case it remains to be determined which is the cause and which the effect.

When one is faced with such a recurring combination, the tendency is to maintain that there is, that there must be, some causal connection. Unfortunately, one is also prone to attribute a causal character to one of the phenomena without requiring valid, scientifically grounded evidence. This remark applies, for example, to the focal theory, which attributes certain peripheral diseases to morbid changes in the tonsils and the teeth, to Wittmaack's "theory of pneu-

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<sup>1</sup> This historical review has been compiled from that of A. Denker and O. Kahler (*Handbuch der Hals Nasen Ohrenheilkunde mit Einschluss der Grenzgebiete*, Berlin, Julius Springer, 1926).

matization," whereby the development of air cell systems of different size is ascribed to infantile otitis and to the supposition that dental caries can be traced to the action of certain carbohydrates, notably "candy" Examples might be multiplied

When a particular view (of hypothetical nature) regarding cause and effect has once been established in the literature, particularly in textbooks, it is liable, owing to faith in authorities, to get firmly rooted in consciousness In the course of one's work one may discover that certain phenomena and symptoms observed clinically do not accord at all with the prevalent beliefs, that others cannot be explained in the light of the accepted theory, and that others, again, do not need it for their explanation For all that, it goes against the grain to return to the starting point and to reconsider whether one is really concerned with a case of cause and effect and, if so, whether it should not be viewed in the reverse direction, what is now regarded as cause being actually an effect, and vice versa

I do not claim that the cause and effect relation between chronic otitis and cholesteatoma has been actually proved to be just the reverse of the present view I am not in a position to show that cholesteatoma is the primary factor and chronic otitis the secondary Here I propose merely to touch on certain phenomena relating to the occurrence of cholesteatoma, on the one hand, and to the symptom complex of chronic otitis, on the other, in order to indicate the superficial way in which these problems have hitherto been investigated The flimsy foundation for the present belief that cholesteatoma originates from chronic otitis will thus be made abundantly clear

Viewed logically, the emphatic statement of Gruber and Tiroeltsch that cholesteatoma of the ear is not a real tumor topples to the ground Obviously, the fact that cholesteatoma of the ear is of far more frequent occurrence than cholesteatoma of the pia mater does not per se rule out the possibility that both may be genuine tumors Nor is this view excluded by the indication that the development of cholesteatoma might be due to the presence of an external irritant The mere mention of the carcinoma of the lips of pipe-smokers will at once make the matter clear Thus, even if chronic otitis were proved to be the precipitating factor in the development of the cholesteatoma, the tumorous character of the latter could not be considered to have been thereby ruled out Moreover, as will be presently shown, it has not even been demonstrated that chronic otitis is chronologically the primary phenomenon and cholesteatoma the secondary This, of course, must be postulated in vindicating the theory that the cholesteatoma is caused by chronic otitis

On the other hand, even if valid grounds could be adduced for denying the tumorous character of cholesteatoma, this obviously

would nowise imply that chronic otitis is the cause or even the primary phenomenon. In short, even if cholesteatoma is not a genuine tumor, it may nevertheless be chronologically the primary formation. In that case chronic otitis cannot possibly be the cause of cholesteatoma.

In any case, there is some difficulty in explaining the origin of a growth, whether tumorous or nontumorous, proceeding from flat epithelium at a place where such epithelium is not "normally" found. It was long supposed that flat epithelium never occurred in the mucosa of the tympanic cavity unassociated with chronic otitis and that cholesteatoma was never found in the aural region except in that connection. It could therefore be considered *nahelegend* to accept Bezold's unproved view that flat epithelium migrates from the auditory meatus through the marginal perforation of the tympanic membrane into the middle ear. Habermann's interpretation of histologic preparations showing a direct communication between the cholesteatoma matrix and the flat epithelium of the auditory meatus could, for the same reason, be pleaded in support of the theory that such epithelium migrates through the marginal perforation.

However, the startling discovery that islands of flat epithelium (besides fully developed cholesteatoma) might appear in the mucosa of the middle ear without the simultaneous presence of marginal perforation or chronic otitis should have aroused suspicion regarding the validity of Bezold's hypothesis and Habermann's "proofs"—thus forcing one to the conclusion that a neoplastic etiologic factor must be reckoned with as a possibility.

The adherence to Bezold's hypothesis as the sole alternative must be ascribed to inertia and to innate reluctance to abandon "knowledge" acquired from standard books. On the other hand, evidence that this hypothesis was wrong could not be produced. Thus, even his patently incorrect statement that when chronic otitis and marginal perforation of the tympanic membrane are associated with cholesteatoma the chronic otitis always manifests itself first was left unfuted.

When, in view of the absence of tympanic perforation, it is inconceivable that flat epithelium could have migrated from the auditory meatus to the middle ear, one must try to account for the presence of flat epithelium, which in certain cases has actually been observed as islands interspersed in the mucosa or in the form of a fully developed cholesteatoma.

It seems strange that in cases of this description, too, for reasons based on analogy, the possibility of a neoplastic origin of the existing cholesteatoma of the ear is still being denied. Such evidence might have been used with equal cogency to declare that in all cases chole-

teatoma of the ear is a tumor as soon as it was shown that a genuine cholesteatomatous tumor might appear in the ear as well as in the pia mater

A number of hypotheses are being set up to explain how flat epithelium may occur in the middle ear in cases in which the tympanic membrane is normal. Thus the origin of cholesteatoma has been attributed to such different factors as epithelial scission from a temporarily intruding funnel-shaped Shrapnell's membrane (Wittmaack), *Keimversprengung* (germ dispersal—Körner, Manasse and Link), metaplasia (Wendt) and trauma sustained at birth or later in life (Kelemen)

Whichever of these hypotheses is accepted, or if actually all of them should be found correct, it is obvious that neither marginal perforation of the tympanic membrane nor chronic otitis is a *sine qua non* for the origin of cholesteatoma. It is also clear that a neoplastic etiologic factor cannot be ruled out—nor can it be proved to be present—in a single case in which cholesteatoma has been observed.

This statement is nowise affected by the indication that metaplasia or growth of the germ—whatever its origin—of a larger or smaller observable cholesteatoma may have been caused by chronic otitis.

In the light of the aforementioned facts it seems justifiable to renew the discussion of the question as to what is cause and what is effect in the relation between cholesteatoma and chronic otitis with marginal perforation of the tympanic membrane. Clinically, at any rate, this is incontestably a common combination.

As regards the question whether there is a connection between marginal perforation and chronic otitis, it should be noted that, unlike central perforation of the tympanic membrane, marginal perforation, as the textbooks indicate, has never yet been observed by anybody to occur in close association with acute otitis. Logically, therefore, it must be inferred that acute otitis is not responsible for marginal perforation of the tympanic membrane, as otherwise the connection could scarcely have eluded observation.

How does marginal perforation of the tympanic membrane then arise? Theoretically, it might be caused by some infection which has a chronic tendency from the outset. But it may also be due to some process of a noninfectious nature. It is conceivable that the perforation may be caused by the destructive effect of an expansive growth, similar to the formation of a fistula of the labyrinth or the breaking down of the internal cortex, with exposure of the meninges, which occurs under pressure of a cholesteatoma.

It is nowise my intention to contend that cholesteatoma, by its destructive action, demonstrably gives rise to the marginal perforation

of the tympanum, but I desire strongly to emphasize that such a process would be analogous to other bone destructions caused by expansive growth <sup>2</sup>

From this point of view one can, at any rate, more easily account for a symptom-free development of such a serious formation as a fistula of bone of the innermost part of the external auditory meatus, where infections otherwise cause intense periosteal pain. It also explains why, according to the textbooks, no one has seen a marginal perforation of the tympanic membrane develop in immediate connection with acute otitis. In fact, one is under the illusion that its development cannot be seen at all. One is so wrapped up in one's idea that marginal perforation of the tympanic membrane is a sure indication of chronic otitis that the mere observation of such a perforation at once arouses the suspicion that it had been preceded by otitis with a chronic course. In the face of the patient, who in many cases is quite unaware of any disease in the ear, one asserts that one knows better, that he must "for a long time" have suffered from an aural disease. Against the patient's emphatic statement that he has never observed any secretion in the external auditory meatus, one maintains that such a secretion must have "previously" occurred. One goes to such lengths in self suggestion that when a marginal perforation is detected in a patient whom, after a recent examination, one has registered as having a normal tympanum, one actually disavows the correctness of one's own observations. In short, one proceeds from the assumption that the previous otoscopic examination must have been defective, since it failed to "detect" the chronic otitis which, one imagines, must have already existed at the time. No wonder that the textbooks assure their readers that no one has ever seen a marginal perforation develop.

If, instead, one sets out from the possibility that the marginal perforation of the tympanum may have been produced from within by the destructive action of a growing cholesteatoma unassociated with otitis (which when it occurs in connection with a marginal perforation may be an intercurrent infection), one will often see marginal perforations develop. And one will frequently see such perforations heal when the desquamated flat epithelium content has been spontaneously discharged into the auditory meatus. In certain cases one will see this "performance" several times repeated (as I myself have), until it finally issues in a permanent marginal perforation of the tympanum, tending to increase in size. It may be added that the tympanic membrane at first need not be involved at all in the fistula,

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2 Diamant, M. Acute or Chronic Otitis, *Acta otolaryng* 25:507, 1937



but will take part in its development after the perforation has been enlarged

If this view is accepted, it will be understood that the marginal perforation of the tympanum is neither "chronic" nor "otitis" It will enable one, however, to throw light on a number of otherwise inexplicable phenomena One can then explain the detection of a cholesteatoma behind a clinically normal tympanic membrane One can explain the less frequent observation of cholesteatoma in cases of central perforation by pointing out that a not yet manifest cholesteatoma might be associated with acute otitis which is causing central perforation One will not need to resort to the artificial explanation that cholesteatoma cannot penetrate from the external auditory meatus through a central perforation, but only through a marginal one, whilst the so-called traumatic cholesteatoma can be accounted for by such relatively slight operative procedures as paracentesis One can explain Jorgen Moeller's<sup>3</sup> case of "genuine" cholesteatoma complicated by acute otitis Finally, one can explain many of the cases in which "traumatic" cholesteatoma is reported to have developed after mastoidectomy or, as just indicated, merely after paracentesis The germ of cholesteatoma may, in fact, have already existed at the time of the operation for mastoiditis of independent origin (Diamant<sup>2</sup>) The cholesteatoma may not begin to grow until a later stage, occurring immediately or some time after the healing, thus obliging the patient again to consult a doctor Now that the cholesteatoma can more easily make its way toward the operative opening, its destructive effect may possibly be avoided There is nothing to gainsay the supposition that the carrier of a cholesteatoma germ may be more liable than others to contract acute otitis (see later comment concerning this point) Nor, of course, is there implied a denial of the possibility that cholesteatoma may develop traumatically in the aural region

Acceptance of the view that cholesteatoma is the primary factor in the development of the marginal perforation and that "chronic otitis" supervenes does not necessarily involve assenting to the belief that cholesteatoma is a genuine tumor The question as to the cholesteatoma germ that originates and develops at a place where flat epithelium is not usually found still remains open and unsettled The foregoing discussion has shown that the question whether the marginal perforation is related to the cholesteatoma need nowise be connected with the view that it is a genuine tumor It has also shown that a denial of the theory that it is a genuine tumor does not automatically imply that cholesteatoma is caused by chronic otitis with marginal perforation of the tympanic membrane

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3 Moeller, J A Case of Primary Cholesteatoma Complicated by an Acute Otitis *Acta otolaryng* 1 309, 1918 1919

As already indicated, I do not claim that without further investigation the hypothesis set forth and the observations reported here can be substantiated. Scientifically convincing evidence can scarcely be based on personal observations which cannot, somehow or other, be reproduced. Though some advance has been made in the pictorial reproduction of the tympanum with the camera's eye, the latter does not enable one to reproduce any regions in sufficient detail to show the successive stages of the development of the marginal perforation. This, however, should not prevent one from realizing that the view according to which cholesteatoma develops in consequence of chronic otitis with marginal perforation is quite as unproved as the theory now advanced that the marginal perforation as well as the supervening infection which is termed chronic otitis may be primarily caused by cholesteatoma.

On the ground of the latter hypothesis, I have for about ten years refrained from making the diagnosis "chronic otitis." I have, instead, diagnosed "*perforatio membrani tympani centralis*" (or "*marginalis*"), adding, as the case might be, "*cum suppuratione*," or "*cum polype*," or "*cum cholesteatoma*." This seems to me to be a more correct designation of a disease the classification of which is actually based on the appearance of the tympanum, the secretion and the occurrence of polypi or of cholesteatoma.

To this, it may be desirable to add a few remarks on a matter which is not merely of nomenclatural interest. One still often finds in the literature the terms "normally pneumatized os mastoideum" and "retarded cellular system." Such expressions, too, seem to me to indicate an unduly uncritical and undifferentiated attitude toward previously acquired book knowledge. I consider myself to have satisfactorily ascertained and shown<sup>1</sup> that the air cell system of os mastoideum varies in normal material from no cells up to systems exceeding in size any which one finds in persons suffering from otitis. The distribution of the different size groups according to frequency shows the typical picture of a normal curve.

If, for a moment, the discussion is transferred to an analogous subject, one finds that human stature, in a normal material, varies about an average figure with a frequency distribution likewise represented by a normal curve. Evidently, however, it is a misnomer to speak of persons showing the average height as being of normal stature. It is a similar misnomer to speak of a mastoid process with an air cell system of average size as "normally pneumatized." In re-

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<sup>1</sup> Diamant, M. Otitis and Pneumatization of the Mastoid Bone. *Clinical-Statistical Analysis, Acta oto laryng.*, 1940, supp. 41, Otitis and Air Cell Systems, *Arch. Otolaryng.* 34:24 (July) 1941.

gaid to a person who is shorter than the average but whose height falls within the range of the normal curve within  $\pm 3 \sigma$ , it is incorrect to say that he is stunted. It is equally incorrect to speak of a "retarded" air cell system in regard to a cellular system of small size—for such small systems may be found in normal persons right down to no cells. The analogy differs only in the fact that in Sweden the statures of mankind, according to the normal curve within  $\pm 3 \sigma$ , range between 163.2 and 193.2 cm. at the age of about 20, according to an article by Broman, Dahlberg and Lichtenstein in the pocket diary published by the pharmaceutical factory Astra, whereas, according to my own investigation, the size of the cellular system varies from 0 to about 30 square centimeters (on a roentgenogram in lateral projection).<sup>5</sup>

These observations on the size of the air cell system are intended to serve as an illustration of the fact that cholesteatoma is usually found in an ear with a small cellular system. I showed (in 1940) the distinct connection between different sizes of the cellular system and different forms of otitis. From this investigation it is evident that marginal perforation of the tympanum occurs precisely in connection with cellular systems which, on an average, show the smallest size. As this is in fact the case, it seems reasonable to suppose that development of cholesteatoma when it occurs in the middle ear is somehow connected with the factors which entail the development of the smallest cellular systems. (This obviously applies even if one accepts the theory that marginal perforation of the tympanum is caused by the destructive action of a cholesteatoma.) It has been shown by Dahlberg and Diamant<sup>6</sup> that heredity plays the principal part in the development of the size of the air cell system. One might therefore presume that it likewise plays some part in the origin of the cholesteatoma germ and the development of cholesteatoma. This, however, is not per se a given fact. The implication is that the cholesteatoma germ and developed cholesteatoma should actually have been observed to occur more frequently in cases in which there is marginal perforation of the tympanum and in which the cellular system is small than in cases in which the cellular system is large and in which there is no marginal perforation. The real truth might be that the cholesteatoma which results in a marginal perforation is placed on record because the accompanying symptoms compel the diseased person to consult a doctor.

Thus, it will be necessary to examine normal material with special regard to the occurrence of the cholesteatoma germ and the developed

<sup>5</sup> For further particulars concerning this subject, see Diamant, M. Risks of Chronic and Acute Otitis, *Acta oto laryng*, to be published.

<sup>6</sup> Dahlberg, G., and Diamant, M. Hereditary Character of the Cellular System in the Mastoid Process. *Acta oto laryng* 33: 378, 1945.

cholesteatoma The difficulties, however, are great in that the cholesteatoma germ, theoretically, may be represented by a single flat epithelium cell (*Keimversprengung*) and may therefore elude detection even in a thorough histologic examination of sections of the tympanic region and its environment

Moreover, the growth of a cholesteatoma germ in the tympanic cavity and its adnexa may possibly be due to causes of an entirely local nature, without any hereditary basis The marginal perforation of the tympanum may thus be traced (1) to hereditary factors giving rise to the cholesteatoma germ in connection with the development of the small cellular system and (2) to an environmental factor stimulating the growth of the cholesteatoma It should be emphasized that the environmental factor need not necessarily be of otitic character

In conclusion it must be reiterated that I nowise claim to have presented cogent evidence in favor of the statements made here regarding the etiologic factors of cholesteatoma or the relation of this growth to marginal perforation of the tympanic membrane and chronic otitis For the sake of completeness, it should be pointed out that the conditions in this respect need not always be uniform It is theoretically conceivable that, whereas in certain cases the cholesteatoma is the primary phenomenon and the marginal perforation secondary, in other cases quite different conditions may exist

The object of this discussion has been to appeal to those of my colleagues who grapple with these difficult problems to try to emancipate themselves from, and to work untrammelled by, the hitherto accepted, but as yet unproved, hypotheses according to which it is supposed that chronic otitis with marginal perforation of the tympanic membrane is primary to and the cause of cholesteatoma of the ear, which is asserted to be nontumorous

## TEST FINDINGS BEFORE AND AFTER FENESTRATION OF THE LABYRINTH

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AND

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WE NEED NOT dwell at length on the importance of carefully selecting the otosclerotic patient for the fenestration operation. Certainly the conscientious operator does not care to handle the poor risk, and likewise the otologist referring the patient does not want to recommend the operation only to be reversed by the operator. Their greatest protection and the best interests of the patient demand a particularly careful preliminary study of the hearing. Not one or two tests are adequate, but, as in all cases of deafness, a considerable amount of evidence must be accumulated and evaluated. The tests discussed in this article are all considered necessary and important.

The following items, of importance in selecting the otosclerotic patient for operation, will not be discussed, as they are not considered pertinent to the title of this presentation: history of the patient, age, recuperative powers, rate of progression of hearing impairment, psychologic aspects and occupation.

### AUDIOGRAMS BEFORE AND AFTER OPERATION

The audiometer curve of otosclerosis varies somewhat, according to the advancement of the pathologic process. In cases in which the loss of hearing is measured early, there is typically greater loss for the lowest frequencies and less loss for the middle and highest frequencies. In cases in which the otosclerosis is moderately advanced, the audiometric curve is nearer a straight line, with still a slightly greater loss for the low frequencies and a probable dip for the 4096 frequency. In cases in which otosclerosis is well advanced, there remains the considerable loss for the low and middle frequencies while the loss for the highest frequencies (4096 and 8192) is still greater, the curve taking a sharp downward trend at these high levels.

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In table 1 are shown the audiograms of the affected ears of 10 consecutive patients with typical otosclerosis—as proved by the finding of a fixed stapes at the operation

An analysis of these audiograms reveals that in general the losses of hearing for the 128 and 256 frequencies are almost exactly the same, the losses for the 512 and 1024 frequencies are almost exactly the

TABLE 1—Results of Audiometric Tests Made in 10 Successive Cases of Otosclerosis

Frequency	LOSS OF HEARING IN GIVEN CASE IN DECIBELS										Average Loss
	147	148	149	150	151	152	153	154	155	156	
128	52	54	47	50	33	43	50	45	48	45	46.7
256	50	55	50	47	37	43	50	45	43	45	46.5
512	57	58	50	58	43	50	47	45	48	45	50.1
1024	57	70	50	58	38	53	48	45	45	45	50.9
2048	55	63	30	53	35	50	50	35	33	53	45.7
4096	50	53	35	47	33	35	60	55	48	58	47.4
8192	40	37	25	60	13	55	65	35	35	70	43.5

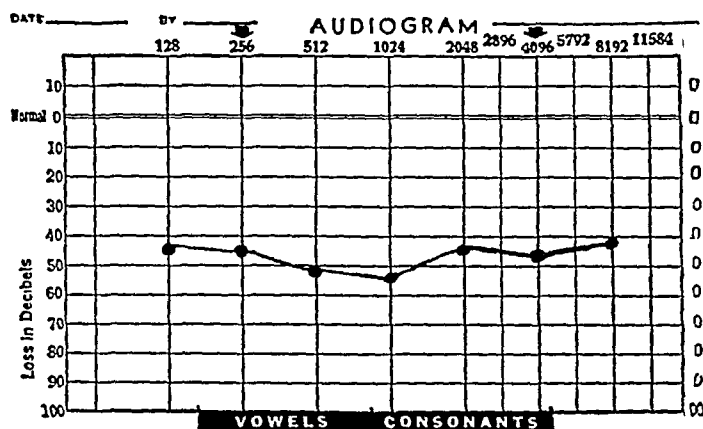


Fig 1—Average audiogram based on 10 typical cases of otosclerosis in which this disease was proved to be present by the finding of a fixed stapes at operation in each case

same but slightly greater than those for the two lower frequencies, the loss for 2048 is slightly less than the losses for lower frequencies, the loss for 4096 is somewhat greater again, while that for 8192 is the lowest of the losses recorded for all frequencies

Although the 10 cases were consecutive, they might be considered somewhat unusual in that in none of them was there the considerable loss of hearing for the two highest frequencies that is so commonly met with in the cases of otosclerosis. Frequently there is a loss of 75 or 80 decibels for the 4096 frequency and a loss of 80 to 100 decibels for

the 8192 frequency without a proportionate loss for the middle frequencies (1024 and 2048). This great loss restricted to the highest frequencies means deterioration of the auditory nerve at those levels, and it may mean that this deterioration has extended, in a lesser degree, to the 2048 frequency or lower. On the other hand, total or nearly total loss for the two highest frequencies may be found in cases in which the loss for 2048 is apparently entirely of a conductive type, as indicated by little or no loss by bone conduction and no great loss by air conduction, and by a considerable improvement in hearing for this frequency after the fenestration operation.

An analysis of the air conduction curves in such cases of otosclerosis is helpful in attempting to determine how much of the hearing loss is conductive and how much perceptive in type. It cannot be conclusive, however, particularly as one does not know how great a loss of hearing of the purely conductive type a person may have. When the

TABLE 2—*Decibel Improvement Obtained by Operation in 6 Typically Successful Cases*

Frequency	IMPROVEMENT OF HEARING IN GIVEN CASE IN DECIBELS						Average Improvement
	147	148	150	152	155	156	
128	38	25	20	23	35	25	27.7
256	35	30	23	33	30	27	29.7
512	43	30	28	35	25	25	31
1024	38	30	23	32	40	25	31.3
2048	40	28	32	30	33	27	31.7
4096	25	15	0	0	30	0	11.7
8192	0	0	0	0	0	0	0

hearing of an otosclerotic patient is improved by operation from the 55 decibel level to the 20 decibel level in the low and middle frequencies, we assume that the preoperative loss of hearing for those frequencies was of the conductive type, and when the operation in this patient produces no improvement in the 4096 and 8192 frequencies, it suggests that the preoperative loss of hearing for those frequencies was perceptive in type.

#### AUDIOMETRIC CURVES IMPROVED BY OPERATION

The frequencies for which hearing is improved by the fenestration operation are those in the low and the middle range.

Fortunately, the greatest amount of improvement is in the hearing for those frequencies that are in the conversational range—512, 1024 and 2048.

Table 2 shows the typical improvement and the amount with respect to the various frequencies in several selected successful cases.

The figures show that the hearing for the three speech frequencies was improved to approximately the same extent, being very slightly better for the 2048 frequency than for any of the others. The improvement for the lowest frequencies is nearly as great as that for the middle ones, with slightly less improvement at 128. The improvement for 4096 is slight and, as is shown in the table, is nothing in half of the cases. In these cases there was no change of hearing for the 8192 frequency in spite of the fact that the preoperative loss of hearing for that frequency was on the average less than that for any of the other frequencies. The figures in this table are shown only to indicate the typical improvement that is noted at each of the test frequencies in highly successful cases. They by no means show the average improvement obtained in a large series of cases.

#### BONE CONDUCTION HEARING

One recognizes, above all things, that good bone conduction is a prerequisite for operation. Yet, one is faced often with inadequate and indeterminate testings to reveal the status of hearing by bone conduction. Masking is essential, and it should be measured masking, that is, masking raised in decibel steps to just the required amount but never to a point where spreading to the opposite or tested ear is observed. Thus one can avoid flooding the head with sound, which puts into the discard all measured testing. Important also is the use of a masking tone that is just below the tone used in the tested ear. We believe that ultimately the present mixed noise used for crowding out the untested ear will be discarded. Fortunate is the examiner who has two audiometers, one of which can be used as the masker. The octave below is adequate if one has not a sweep oscillator, which will bring the masking tone ideally nearer, but still below, the tone used in testing.

Masking certainly should be done in the untested ear if the hearing of this ear is 30 to 40 decibels better than that of the tested ear. This applies to both bone conduction and air conduction testing. One can conveniently use either a bone conduction or an air conduction receiver in order to mask, depending on whether one is testing the opposite ear with air conduction or with bone conduction. A most exact method is to use a bone conduction masker when testing with air conduction and vice versa. Then the testing air-conducted or bone-conducted tone may be applied to the untested ear and the loudness of the masking sound can surely be raised to a level to dampen it out. Thus one can be sure of using only just the needed amount of masking, avoiding flooding the head with sound.

"Hearing across the head" can be an actuality and must be constantly kept in mind and guarded against. One cannot altogether de-



pend on the patient's reporting as to which ear is doing the hearing. Herein lies the value of using different pitches for masking and testing. The patient can identify each.

One consideration in bone conduction testing, whether with audiometer or with fork, is the avoidance of air-borne sound. The most definite assurance in this matter is to run off a reporting by the patient of loudness of levels at which different pitches are heard when the bone conduction receiver or the fork is held in the bone conduction position but not in contact with the bone. It is well to make a record of the findings so as to compare them with those obtained later with the routine bone conduction technic. If at any pitch the two reportings coincide, the examiner cannot tell what the patient reported—air conduction or bone conduction.

The matter of bone conduction hearing before and after operation is interesting. Since usually only the patients with good bone conduc-

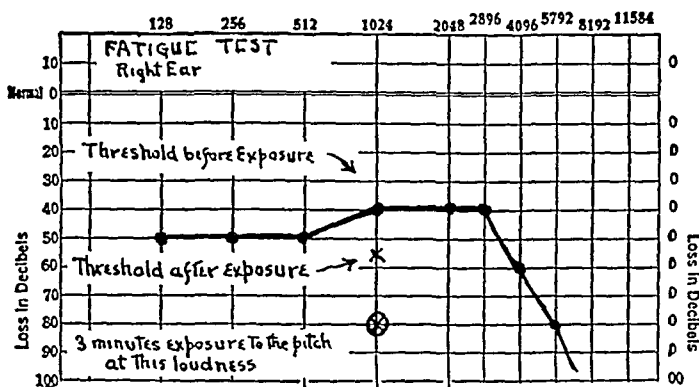


Fig 2—Recording of the fatigue test. The right ear and a pitch of 1024 cycles per second were used. The threshold at the start was 40 decibels. The ear was exposed to the frequency mentioned for three minutes at 80 decibels. After this three minutes the threshold was 55 decibels, after four minutes it was 50 decibels, after five minutes it was 45 decibels, after six minutes it was 40 decibels. Conclusion: There had been 15 decibels fatigue, with recovery in three minutes.

tion hearing are operated on, there should be little or no change in this hearing. However, errors of testing may be made, for the patient whose air conduction is benefited by operation has better hearing of air-borne sound when one is testing for bone conduction hearing. Again, one must take a frequency run with the bone conduction receiver "just off" the mastoid, to see what may erroneously be reported for bone conduction hearing.

#### THE FATIGUE TEST

Auditory fatigue does not show up in catarrhal deafness nor in early otosclerosis but it does appear in all types of nerve deafness. The test needs usually to be performed with but one or two frequencies, preferably in the speech-hearing zone. It is well to pick a pitch

for which there is sufficient hearing to allow for delivering of a loudness 40 decibels above the patient's hearing threshold. This loudness is left on for three minutes, and then the patient's threshold is retested every thirty seconds. Recovery does take place, either slowly or rapidly. The test gives another means of separating nerve deafness from conductive deafness.

#### THE GELLÉ TEST

The Gellé test is believed to be not as popular in this work as it should be, and yet one should depend on it greatly. Certainly, a normal result of this test suggests that if an otosclerotic process is present it has not attacked the stapes. We definitely believe, from both testing results and from what is seen at operation, that there can be varying

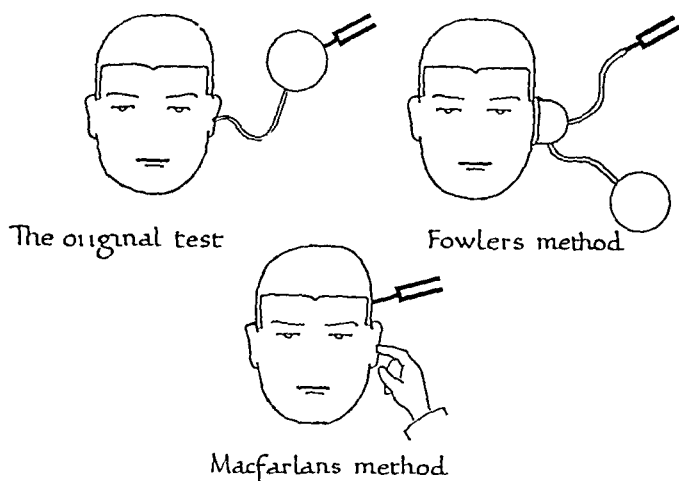


Fig 3—Methods of making the Gellé test

degrees of fixation. In testing we have found the Gellé test eliciting a more and more positive response as the disease progressed. When some fixation is surmised and when the rest of the picture points to otosclerosis, one is more than ever influenced toward early operation. Late, complete fixation accompanied by poor hearing of bone conducted sound means that the case has gone too far.

We submit a convenient modification of the classic Gellé technic. The old technic is often limited by reason of the patient not being able to hear the sounding fork placed against the bag. Further than this, the air escaping out of the auditory canal when pressure is applied interferes with hearing. In the attempt to avoid this leakage, too much pressure of the tip being pushed into the ear produces a premature Gellé effect before reporting begins. The new technic is to hold the butt of the fork on the mastoid process and to use the index finger to exert pressure on the column of air between the meatus and the drum.

Intensity matching, loudness balance, recruitment (call it what one may) gives a definite demarcation between "operable and "in operable" loss of hearing in patients with otosclerosis. The test is simply an attempt to reach equal loudness of sound in each ear by raising the intensity. It cannot be accomplished if the deafness is due to an obstructing process but can be if there is nerve deafness. Fortunately, there is usually enough disparity between the two ears at some pitch to make the test possible. Fowler's very original discovery will tell one when the end organ is being choked by otosclerotic disease.

Otosclerosis in the beginning and in the "operable" stage is clinically a conductive deafness and loudness balance is impossible. Fowler believes this to be the case always in otosclerosis, yet we seem to find it otherwise when the disease has advanced to the point where the perceptive apparatus is damaged. Of course, in this stage the hearing by bone conduction is also down and there will be no benefit from operation. Degrees of intensity matching are seen, just as degrees of stapes fixation are seen.

The foregoing statements on loudness balance are compromised by the fact that the high frequencies may be choked in the cochlea if otosclerosis is in the advanced stage. Then there could be loudness balance in these frequencies typical of perceptive deafness, while the lower pitches, unaffected as yet by the cochlear choking, would still give the finding of absence of matching as seen in conductive deafness.

#### HEARING OF SPEECH BEFORE AND AFTER OPERATION AND ITS CORRELATION WITH AUDIOMETRIC HEARING

The desirability of obtaining a record of the hearing of speech as well as of the hearing of the pure tones of the audiometer before and after operation in all cases of otosclerosis is being recognized more and more, and speech and pure tone audiometers are being developed to correlate accurately such measurements of hearing.

Now one has a definite and metered way of testing the hearing of speech, and the thresholds, as well as the efficiency of hearing at different loudness levels, can be sharply determined by interpretation tests with a phonograph audiometer.

An unamplified phonograph may be brought at small cost. The turntable should be electrically driven, the pickup should be the crystal type and there should be an intensity trimmer on the instrument. The output of the phonograph is plugged into the microphone outlet of an audiometer, and, thus used, the audiometer supplies the necessary amplification and a decibel meter. The patient hears the speech coming from an ear phone. The record should be one in which the speech is recorded at a definite constant intensity or loudness. The

decibel meter allows one to change the loudness in decibel steps, so that exact threshold readings for speech hearing are obtained. The record developed by one of us contains on one side a list of numbers and on the reverse side a series of common monosyllabic words. Preferably, the number side is used for threshold testing, while the common word list is used in testing the efficiency with which speech is

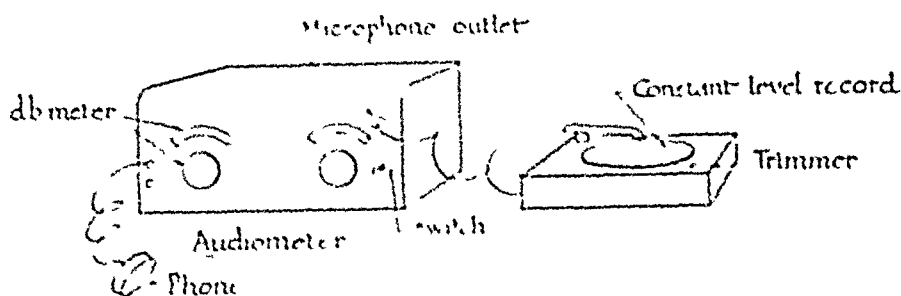


Fig 4—Simple and practical phonograph audiometer for determining the hearing of speech. Phonographic speech is fed into the microphone circuit of the audiometer and is varied at will as to loudness by the decibel meter dial.

Dr Macfarlan's Test Method			
Record No. 1			
55--Two Digit Numbers--Constant Level			
48	85	62	41
23	66	32	81
66	64	38	68
41	58	43	21
81	38	52	
68	18	51	
21	23	22	
15	48	56	
43	63	65	
31	83	25	
24	32	16	
56	85	84	
55	63	32	
54	18	64	
88	24	48	
42	88	23	
23	25	66	

Fig 5—Numbers recorded on a phonograph record at constant intensity

interpreted at various levels of intensity. It is surprising to find that the patient's reporting is as accurate for speech as it is for pure tone (A most careful recording of a flat intensity record is essential).

Walsh and Silverman<sup>1</sup> have made a most valuable and original contribution to speech audiometry as carried on at levels above three

<sup>1</sup> Walsh, T. E., and Silverman, S. R. Diagnosis and Evaluation of Fenestration, *Laryngoscope* 56 536 (Sept.) 1946

hold Their work analyzed the improvement in interpretation as speech sounds were made louder and louder The patients with conductive deafness showed continuously better hearing as loudness was increased, whereas with nerve deafness a level of loudness was reached at which there was an end of the patient's maximum efficiency Beyond this, greater loudness did not make for better hearing The test is invaluable for differential diagnosis, particularly in cases of otosclerosis Here is another means of separating cases in which the patient would be benefited by operation from those in which the disease has advanced to cochlear damage

### Dr Macfarlan's Test Method

Record No. 2

#### 48 Common Monosyllables--Constant Level

Boy	Green	Light	Play
Good	Bird	Hard	Milk
Cold	Blue	Burn	Stop
Hand	Lip	Horse	Train
Go	Ear	Look	Walk
Eat	Long	Girl	Man
Give	God	Head	Love
Love	By	Bear	Sun
Door	Big	Low	Tree
Child	Box	Black	Two
Drink	Lost	Ball	Now
Egg	Book	Home	You

#### 14 Monosyllables for Pre-school Child Test

Constant Level

Box	Dog	Girl	Boy
Apple	Bird	Door	Ball
Ball	Boat	Book	
Moon	Boy	Bell	

Fig 6—Monosyllabic words recorded on a phonograph record as constant in intensity

One cannot but compliment Lempert and his followers on the high goal which they set for themselves in choosing the objective of social and economic restoration of the hearing of speech Is the goal too high, and is it excluding cases in which there is a possibility of obtaining an improvement of hearing in persons who suffer from more severe loss? Surely the deafened will welcome any hearing improvement Even though the benefit may not be so great as to permit them to discard a hearing aid, is not much to be gained by the better hearing which the aid will produce after the operation? In considering these questions, two things must be understood—(1) the loudness of normal speech and (2) the point where speech hearing disability begins In average conversational situations the speech of a person

with normal hearing is of a loudness of 10 decibels above audible sound. With the kind of hearing, difficulties in the hearing of speech are definitely noticed at a 20 decibel loss in interpretation testing. The person with a 20 to 25 decibel loss will say "I can get along under most circumstances. It is only once in a while that I encounter a low speaking voice, or one in which articulation is slurred or poor. Then, too, I am bothered with persons speaking too rapidly. I do not have time to catch all that they say." Cross talk difficulties appear with this loss, but telephone conversation is invariably satisfactory. At a 30 decibel loss lapses of auditory attention begin to appear. It is too much of an effort to keep trying to hear. At this stage these people begin to withdraw from, and avoid as many speech contacts as pos-

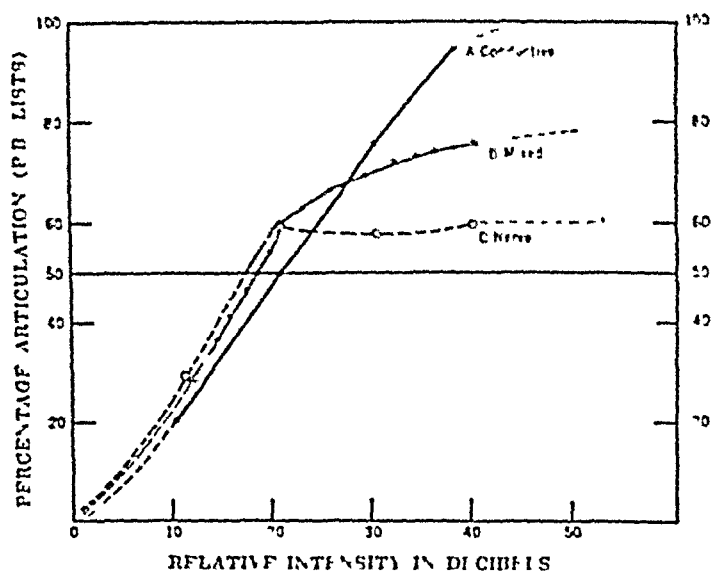


Fig. 7—Articulation for conductive, mixed and nerve type deafness (from Walsh and Silverman 1)

sible. Fear of making mistakes in understanding begins. Office workers are afraid they will not get correctly the directions or the dictation given them. Sensitiveness and nerve strain appear. It is at this point that a hearing aid and lip reading jump the patients back over the barriers of lapses of attention or mistakes of hearing. At a 20 decibel loss or better, to which the hearing aid boosts them, they no longer have to make the effort to hear. The critical zone, then, can be said to be in the neighborhood of the 30 decibel loss. It seems to be a matter of simple mathematics to say that if an otosclerotic patient with a 50 decibel loss of hearing is helped to the 30 decibel loss by an aid, the fenestration operation, even if it reduced the loss but 10 decibels, would be a great boon.

It is a source of great satisfaction to see the workers in fenestration lead the way to an appreciation of the importance of speech hearing. In considering both rehabilitation and the patient's point of view, it had to be so. Frequency audiometry, with its deduction as to the capacity to understand speech, has long been misleading as to the hearing of speech. It seems advisable to accept the dictum that one cannot expect to know what the hearing of speech is from the study of an audiogram.

In tables 3 and 4 are recorded the speech reading and the audiometric reading before and after operation of each of 10 consecutive otosclerotic patients who were subjected to the fenestration operation.

TABLE 3—*Speech Readings Before and After Operation*

	LOSS OF HEARING FOR SPEECH IN GIVEN CASE IN DECIBELS									
	147	148	149	150	151	152	153	154	155	156
Before operation	60	70	50	65	50	50	65	60	55	60
After operation	30	40	35	35	30	30	45	25	25	35
Net improvement	30	30	15	30	20	20	20	35	30	25

TABLE 4—*Audiometric Readings Before and After Operation*  
(Average for the 512, 1024 and 2048 Frequencies)

	LOSS OF HEARING FOR SPEECH IN GIVEN CASE IN DECIBELS									
	147	148	149	150	151	152	153	154	155	156
Before operation	57	64.6	43.3	56.3	38.3	51	48.3	41.6	45.3	47.6
After operation	15	35	36.6	28.3	28.3	18.3	30	16.6	11.6	21.6
Net improvement	42	29.6	6.7	28	10	32.7	18.3	25	33.7	26

A study of these postoperative findings reveals considerable variation in the comparative improvements to pure tones and speech, so that accurate correlating of one with the other is difficult or impossible. One cannot predict from the frequency graphs taken after operation what change has taken place in the hearing of speech. The graph may be better as compared with the speech reading, or the opposite may be found. In general it will be discovered that the speech level of hearing after operation as recorded in decibels is not as good as the pure tone level. In these 10 cases the average speech level after operation was 33 decibels, while the average pure tone level was 24.

Further comparisons may be made in the speech and audiometric readings in connection with the various frequencies involved. Has it

been found that the hearing of speech after operation has any relation to the particular audiometric frequency that indicates improved hearing? In table 5 is shown in decibels, the amount of improvement found in speech and in pure tone hearing after operation in the same 10 cases, also, the improvements obtained for the three speech frequencies individually.

It has been mentioned by observers of patients who had been operated on that a postoperative improvement of hearing for only the one frequency 2018 will give a substantial improvement of the practical hearing of speech and this appears to be substantiated by analysis of these few cases. However, an improvement obtained for the 1021 frequency will give a further rise in the hearing of speech

TABLE 5—Decibel Improvement Found After Operation

	DECELS IN DB. GIVEN CASE 1 DECIBELS*									
	1.7	1.5	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6
Audiometric improvement	12	20.6	6.7	28	10	22.7	18.3	25	33.7	26
Speech improvement	27	20	15	20	20	20	20	25	30	25
Improvement at 512	13	7	0	21	5	25	15	25	25	25
Improvement at 1021	28	20	10	25	13	23	5	25	42	25
Improvement at 2018	15	28	10	20	10	0	25	25	33	28

and an improvement for the 512 frequency, in addition to the improvements for 2018 and 1021, will give a still further boost to the hearing of speech.

### TINNITUS

One must not omit consideration of tinnitus when it is present in any deaf patient, for tinnitus alone may greatly influence hearing in the zone where it lies. A note on the audiogram should show the region of the predominate pitch present in the noise. Quantitative measurement of the tinnitus is possible only by testing the hearing both when the noise is absent and when it is present. Subtraction of the two findings gives an acceptable index.

### VESTIBULAR TESTS

Since one feels obliged to collect all available evidence on the otosclerotic patient, the vitality of the vestibular apparatus must be studied. It either has or has not been influenced by the disease. Its reactions will surely give a clue to the extent, if any, of the involve-



ment, and this may be an added item in deciding for or against operation. Otolologists in general have different preferences for vestibular tests, but whether the tests be turnings or fractional or massive douchings, the information sought for is the same. Is, or is not, the vestibular apparatus involved?

#### VERTIGO AND THE FISTULA TEST AFTER OPERATION

All performing fenestration have had considerable experience with vertigo and fistula reactions after operations, but few have recorded in the literature any details of these reactions. Brunner and Cutler<sup>2</sup> recently reported their observations based on 12 cases of fenestration. They reported having seen during the first twenty-four hours after operation horizontal and rotatory nystagmus of the third degree directed toward the side not operated on. After twenty-four hours they invariably observed horizontal and rotatory nystagmus of the third degree directed to the side of the operation, which disappeared in a few days. In addition, they frequently found slow oscillatory movements of the eyes, synchronous with the pulse and occasionally associated with nystagmus of the head. They compared the labyrinthine findings subsequent to surgical injuries of the semicircular canals with those subsequent to the fenestration operation and noticed in the cases of injury that the spontaneous nystagmus was invariably to the opposite side and thus differs in direction from the nystagmus following fenestration. They attributed this difference to the infection which, they stated, was always associated with the surgical injury, while infection was usually absent in the fenestration. They further stated that if the nystagmus noted after fenestration was directed to the opposite side it was probable that an infection of the fenestra had occurred and that for this reason the operation would not be successful.

Our own observations of the postoperative vertigo and nystagmus of a large number of patients are considerably opposed to those of Brunner and Cutler. Accurate evaluation of the nystagmus occurring during the first twenty-four hours after fenestration is difficult because of the fact that the patient, during this period, is usually extremely drowsy and uncooperative, owing to the rather considerable preoperative sedation. There is difficulty in inducing the patient to arouse sufficiently to fix his attention or vision on a particular object so that nystagmus can be observed. During the analgesic stage, however, during the first eighteen to twenty-four hours a variety of nystagmic movements have been observed. The most constant of these is the slow drifting of the eyes to the side operated on, and in those

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2 Brunner, H., and Cutler, M. H. Labyrinthine Symptoms Subsequent to Fenestration of the Labyrinth, *Arch. Otolaryng.* **45**: 613 (June) 1947.

patients who can arouse sufficiently to fix their eyes there is a horizontal and rotatory nystagmus to the opposite side, the side not operated on. While this is the type of movement most commonly observed, it is by no means always seen. On several occasions the quick component directed to the side operated on has been observed, but this has changed at times during the first day to nystagmus directed toward the side not operated on, and in 2 instances to a distinct downward nystagmus.

No particular determination of the significance of this changing nystagmus which is observed during the first day has been attempted, but it appears to be connected with the prolonged effect of the pre-operative sedation and the general anesthesia which these patients undergo at operation. Light nitrous oxide was used throughout the operation in the great majority of these cases of fenestration. When the patient can be aroused sufficiently to cooperate, the nystagmus is nearly always to the side not operated on. The various other eye movements observed are mixed and changeable. In all cases the early nystagmic movements are associated with intense vertigo and severe nausea and vomiting which is frequently spontaneous through the day and always increased with any disturbing of the patient.

The slow oscillatory movements of the eyes and the nystagmus of the head which have been mentioned by Brunner and Cutler have also been observed by us and are found fairly constant, the degree depending largely on the severity of the labyrinthine reaction.

On the day following the operation almost invariably the nystagmus has been found to be firmly established in the direction toward the ear not operated on. This is the reverse of that reported by Brunner and Cutler. The rapidity and the amplitude of these eye movements vary according to the intensity of the vestibular reaction as registered by vertigo and nausea of the patient. This spontaneous nystagmus usually gradually becomes less marked each day following the operation and in nearly all the cases disappears in from six to twelve days. It is accompanied by vertigo, nausea and frequently vomiting for two or three days following the operation, but in the average case the vertigo and nausea have subsided sufficiently by the end of the third day so that the patient can leave his bed and walk a short distance. Varying degrees of vertigo and sense of unbalance, however, remain with the patient for ten days to a month. During this period following operation, beginning a day after fenestration, the nystagmus, if present at all, is toward the side not operated on.

The fact that the predominate nystagmus is directed to the opposite side for several postoperative days, associated with improvement of the hearing and active fistula response, in our opinion does not mean that infection of the fenestra has occurred, as suggested by Brun-

ner and Cutler It means, we believe, that the labyrinth is reacting as it should to the traumatic stimulation it has received during the operation In none of over 200 patients operated on, has there been to our knowledge an actual infection of the labyrinth, as there have been no clinical symptoms suggestive of such an occurrence The strictly aseptic surgical technic and the prophylactic use of penicillin permit of the manipulation of such delicate structures without fear of an immediate infection It is true that a rather large percentage of the mastoid cavities become infected at some stage following operation, but in no case has there been observed any symptom referable to the labyrinth that would indicate infection of that structure

#### THE FISTULA TEST AFTER FENESTRATION

The postoperative reaction of the labyrinth to the fistula test is of interest and yields a rich field for study and speculation Some operators place much importance on this response in estimating the success of the operation Others consider it of little significance as far as the result of the operation is concerned There are commonly seen two types of results—the negative type, the test having elicited no labyrinthine reaction, and the type in which some nystagmic movement is produced

The test can be made in the usual way by compressing or aspirating the air of the auditory canal, or it can be made by pressing the fenestrated area or the area adjacent to it with a cotton-tipped applicator The latter method is commonly employed during the process of cleaning the aural cavity during the postoperative period It does not as accurately register the response of the vestibular apparatus concerned as does the compression and aspiration method With the latter method the typically positive result is the production of nystagmus directed to the side of the compression and then, with aspiration, to the opposite side

*Significance of the Positive Result*—When the response to the fistula test is extremely active, it is considered by most operators a favorable sign as far as the hearing result is concerned It indicates that the labyrinthine function has not been damaged by the operative procedure or by the postoperative reaction, and it shows that there is little or no obstruction to the passage of stimuli such as touch or sound through the fenestra Both of these are conducive to a good hearing result, and it can be stated that on the whole the more active the response to the fistula test the greater is the postoperative improvement of hearing

There are, however, exceptions to this rule At times the postoperative fistula test will elicit no response or weak nystagmus when

the improvement of hearing has been considerable. At other times, as has been observed by many operators, there has been no postoperative improvement of hearing in the presence of active nystagmus. An explanation of some of these phenomena is entirely lacking at this time in many instances.

*Significance of the Negative Result*—It has been the experience of all operators to find that in some cases the fistula test produces no labyrinthine response after operation. In probably the majority of cases this negative result is seen in those cases which are considered failures. It means, at least in many instances, that the vestibular mechanism has been damaged and is not capable of functioning. Some times this damage and the resultant loss of function are permanent, but frequently the damage is only temporary, and full labyrinthine function is restored after weeks or months.

In a rather large percentage of the patients operated on the immediate effect during the first postoperative day and sometimes for several days is a considerable improvement of hearing coincident with severe vertigo, nausea and nystagmus. In this large percentage the initial improvement and severe labyrinthine reaction are followed by a considerable reduction of the hearing, often well below the preoperative level, along with relief of the vestibular excitation. When the packing is removed from the areas of operation on the third to sixth day after fenestration, it is found that the fistula test produces no response.

In such cases the status of the vestibular apparatus is in doubt. The labyrinth is not dead, as is proved in most cases by the full recovery, in days, weeks or months, of vestibular function. It appears to be in a state of suspended function or of fatigue, and the cochlear function is usually involved in a similar way and to a parallel degree. At times this state of suspended function will be changed quickly—in a matter of hours—to a state of active function with, again, marked improvement of hearing coincident with return of vertigo, nausea, nystagmus and a positive response to the fistula test. At other times the change back to active function is slow and gradual—over a period of days to weeks—with gradually increasing fistula response and gradual improvement of hearing. Again, at times there is never any return of positive reaction to the fistula test, and this frequently means that the hearing result will not be good. However, this is not always so, as some patients will reveal satisfactory improvement of hearing though the fistula test gives no positive result at any time.

Following operation, all degrees of positive reaction to the fistula test may be discovered, from the degree in which the light touching of a cotton-tipped applicator to the fenestrated area may nearly throw

the patient to the floor to the degree in which only a mild response can be elicited by considerable pressure of a cotton-tipped applicator. As mentioned in a foregoing paragraph, in the majority of instances the active response to the fistula test is observed in the patients with the better hearing, but, as also mentioned, there are notable exceptions to this. Adequate explanations of these varying labyrinthine reactions are not available at the present time, and their full significance must await further study and experimentation.

#### TESTS AVAILABLE FOR DIAGNOSING OTOSCLEROSIS IN AN "OPERABLE" STAGE

There is herewith presented a list of the testing items suggested by this study:

- 1 Air conduction audiometry
- 2 Bone conduction audiometry—good bone conduction is necessary
- 3 Fork testing of bone conduction hearing, 512, 1024 and 2048 being used—good bone conduction is necessary
- 4 Fatigue test—no evidence of fatigue appears in early otosclerosis
- 5 Gellé test—patient's response must be negative
- 6 Matching of loudness in the two ears by raising the intensity—impossible in early otosclerosis
- 7 Speech-hearing tests showing a loss of hearing over 30 decibels, and articulation tests showing conductive deafness
- 8 Caloric test

In conclusion, we have presented our observations as to audiometric and speech-hearing tests made before and after operation. We have suggested what one may expect to find in the cases in which deafness due to otosclerosis may be dealt with successfully by operation. There may be added a number of hearing tests which we believe to be of considerable value in arriving at a true and appraised diagnosis. We believe that if one will use and obtain experience in making all of the tests, a truer picture of otosclerosis will be obtained, and likewise, that greater discrimination will be exercised in selecting the patient who can be benefited by operation.

#### SUMMARY

In selecting the patient whom one may treat successfully by fenestration of the labyrinth, it is important that the deafness be carefully evaluated to determine as far as possible how much of the impairment is of the conductive type and how much is of the perceptive type. This can be done, in a large measure, by the following tests:

- 1 Audiometric tests of air conduction hearing. A careful study of the pure tone audiometric curves of deafened persons is helpful

but not conclusive in estimating the amount of conductive and perceptive loss

2 Audiometric tests of bone conduction hearing Although the testing is occasionally confusing and misleading, on the whole it is of great value in estimating the type of deafness if properly done Measured masking is essential, and it is important to check the airborne sound from a bone conduction receiver

3 Fork testing of bone conduction hearing This type of testing can be of great value in estimating cochlear function if the many factors of error are recognized and guarded against

4 Fatigue test Auditory fatigue does not show up in catarrhal deafness or early otosclerosis

5 Gellé test Here also are numerous factors of error, but the test can be of value in the hands of the experienced tester

6 Loudness balance test Matching of the loudnesses in the two ears by raising the intensity is impossible in the stage of otosclerosis considered operable

7 Speech hearing tests In the differentiation of deafness these tests are of value particularly that involving articulation interpretation

8 Caloric test The vestibular response to stimulation such as turning or water douching is helpful in estimating the functional activity of the inner ear mechanism

In a study of the speech and the pure tone hearing improvement obtained by the fenestration operation, no definite correlation between the two could be discovered The pure tone hearing may be better as compared with the speech hearing, or the opposite may be found

A study of the postoperative vertigo and fistula reactions of a large number of patients was made, and several observations were noted The nystagmus following in operation was almost invariably directed to the nonfenestrated side The majority of patients operated on showed an active response to the fistula test as performed by compressing the air of the auditory canal or by pressing a cotton-tipped applicator to the area of operation The active postoperative fistula response is usually associated with the best hearing result A good hearing result may be obtained in the absence of a positive reaction to the fistula test at any time after operation There may be no postoperative improvement of hearing in the presence of an active fistula response Adequate explanations of the varying labyrinthine reactions observed after operation are not available at the present time, and their full significance must await further study and experimentation

## PHYSIOLOGIC SURGERY OF THE NARES

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**R**HINOPLASTIC SURGERY has now developed to a point where it must move in the direction of physiology<sup>1</sup> if its functional results are to keep pace with its esthetic attainments. This objective can be realized only through a closer cooperation between the rhinologic surgeon and the physiologist. Unfortunately, the problem of adjusting physiologic theory to practice is difficult. The physiologist who does not directly observe surgical treatment and its results finds himself at a disadvantage in that he is unable to check his theoretic contributions as applied to surgery. The surgeon, on the other hand, has always been reluctant to accept physiologic opinion on the ground that the experimental process in itself interferes in some measure with the phenomena to be observed. He feels that physiology at best presents a rather fragmentary synthesis, which provides only a more or less approximate understanding of any concrete or specific problem.

This gulf must somehow be bridged, for only by the integration of surgery and physiology can both departments advance effectively. The surgeon cannot deny that surgical planning, in its essence, involves predictions, all of which must be predicated on physiology, and the more complete the physiology the more accurate the prediction. As for the physiologist, the demands of surgery for the solution of unsolved problems will greatly widen the scope of his field. Once the findings of his science are applied to the exigencies of surgery and tested out in the operating room, there will be opportunities for revising his theories with benefit both to him and to the surgeon.

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Presented in part as the Brkett Memorial Lecture before the Canadian Medical Association at McGill University, Montreal, Canada, May 9, 1947.

1 (a) Fomon, S., and others. *Rhinoplastic Analysis, Eye, Ear, Nose & Throat Monthly* 24: 19-24 (Jan.) 1945. (b) Fomon, S. *Surgery of Injury and Plastic Repair*, Baltimore, Williams & Wilkins Company, 1939. (c) Fomon, S., Syracuse, V. R., Bolotow, N., and Pullen, M. *Plastic Repair of the Deflected Nasal Septum*, *Arch. Otolaryng.* 44: 141-156 (Aug.) 1946.

We shall try to rationalize the surgical procedures from a functional standpoint in an effort to show that rhinoplasty should be considered an integral part of present day rhinology.

#### CLINICAL ANATOMY

The nares open on the base of the nose and are separated from each other by an anteroposterior septum, the columella. Their downward direction protects the vestibule against the introduction of foreign bodies. They vary from mere slits to voluminous openings and differ in shape and direction with race, heredity, trauma, disease and individual characteristics. In the white race they are elliptic ventrodorsally, while in negroid races they are nearly round, their long axes tending to lie horizontally. It is thought that the direction and the shape of the nostrils bear some relation to the geographic environment. Thus, inhabitants of dry, cold climates have long noses with narrow nostrils directed downward, these adaptations cause the height of the column of air entering the nose to be raised and its flow retarded, thereby helping to insure that the air will be moistened and warmed. Conversely, those dwelling in hot climates have short noses with large nares, directed forward, thus the height of the curve is lowered and the time during which the air remains in contact with the nasal mucosa is shortened.

The simplest and perhaps the most satisfactory method of analyzing deformities of the nostrils is that dependent on the use of photographs, a face view, a left and a right profile view and a basal view,<sup>1</sup> the photographs being taken half life size and always under similar conditions of lighting and position.

The full face view demonstrates defects in the symmetry, the width and the tip length of the nose (fig 1*A* and *B*). To analyze—

- 1 Draw vertical lines through, first, the midintercanthal point and the center of the lip, *a—b*, second, the right inner canthus, parallel to the central line, *c—d*, third, the left inner canthus, parallel to the central line, *e—f*. The nasal components in the two compartments thus formed should be identical. The alae should be tangent to line *c—d* and *e—f*. If they fall within these vertical lines, the interalar width is deficient. If they fall outside these lines, the base is too wide.

- 2 Draw two horizontal lines through, first, the eyebrows, *g—h*, and, second, the alar-labial junctions, *i—j*. Divide the horizontal space thus formed into quarters by lines *k—l*, *m—n* and *o—p*. If the height of the alae is correct, line *o—p* will fall tangent to their upper margins.

Note the highlights along the dorsum and the tip for width. The nasal tip should fall slightly below line *i—j* (it is assumed that the photograph was taken with the head in the Frankfort horizontal position). If it lies above this level, the nose is too short, if it lies more than slightly below, the nose is too long. The length of the nose is more accurately determined, however, in profile view.



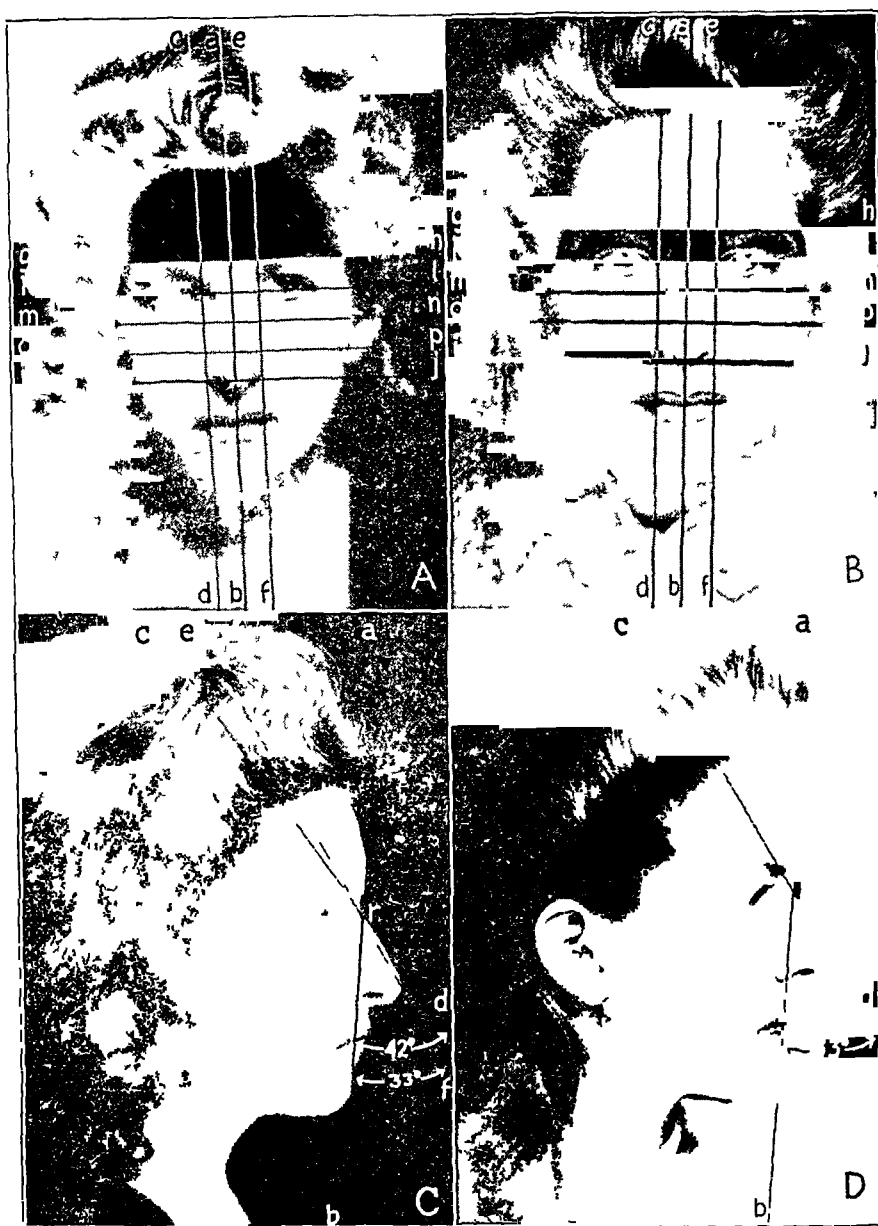


Fig 1—Photographic analysis of the lobule before and after correction  
A and B, face view, C and D, right profile (See text)

The profile view best demonstrates the projection of the tip and the length of the nose

On the photograph of the right profile (fig 1 C and D) 1 Draw line  $a-b$  through the most projecting parts of the forehead and the chin 2 Draw line  $c-d$  along the most projecting part of the dorsum of the nose, bisecting  $a-b$  at the nasal root,  $r$  3 With a protractor measure angle  $b-r-d$  Ideally, this angle should be 30 to 38 degrees, and the tip should project 2 to 3 degrees beyond the dorsum 4 Without removing the protractor, mark off a point at

30 to 38 degrees 5 Draw line  $e-f$  The difference between the existing projection and the ideal indicates the amount of reduction necessary

The photograph of the left profile (fig 1 *L* and *I*) is used to determine the length of the nose The most pleasing outline is one in which the nares form an angle of 90 degrees in men and 100 degrees in women with the line of the

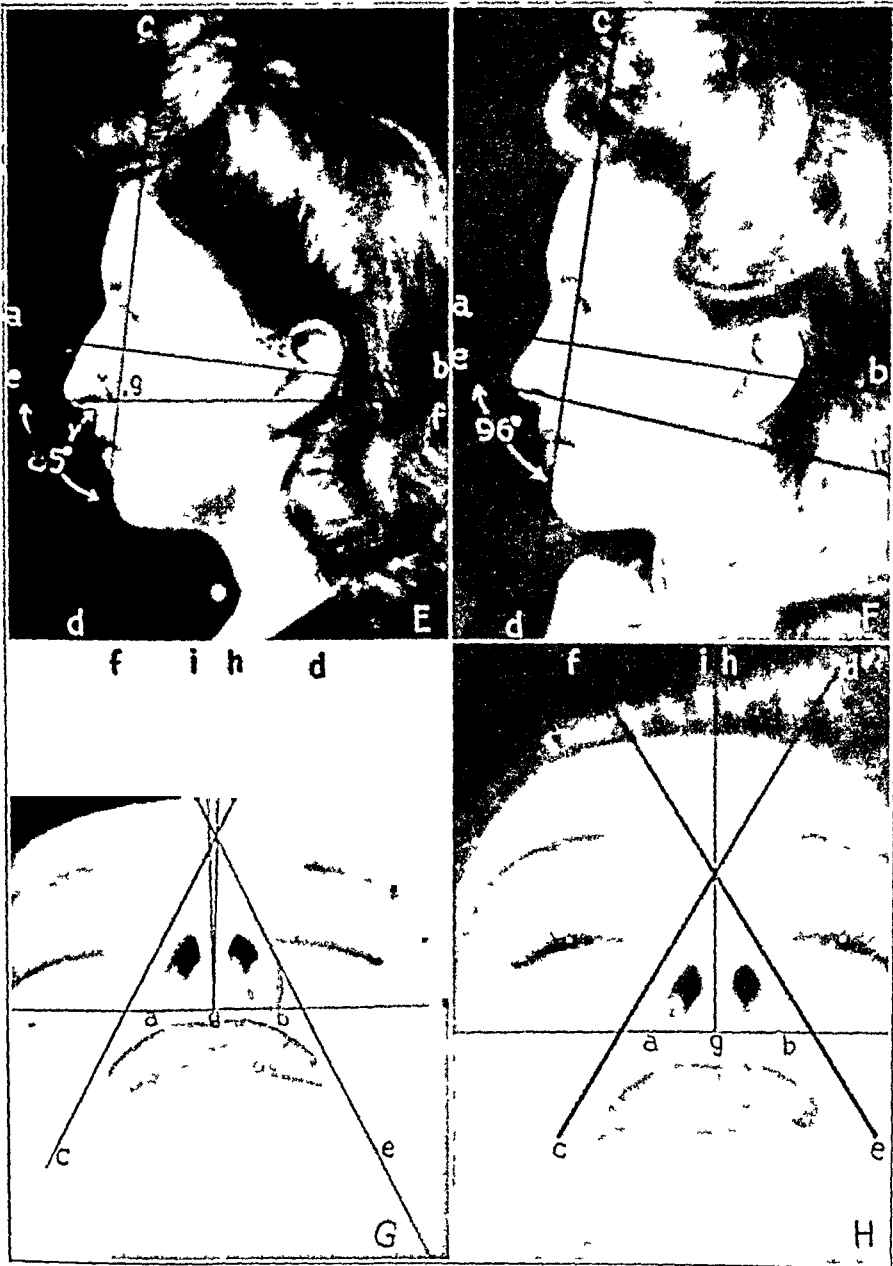


Fig 1—*L* and *I*, left profile *G* and *H*, basal view (See text )

upper lip Owing to the great variability of the shape and the inclination of the lip, the old method of using the lip as a landmark has been discontinued and the following substituted

1 Draw a line,  $a-b$ , through two points, one at the center of the lower rim of the orbit and the other at the depression above the tragus (Frankfort

horizontal plane) 2 Draw a line,  $c-d$ , perpendicular to  $a-b$  and tangent to the alar-facial junction Mark the point of intersection  $g$  3 Draw a line,  $e-f$ , through the long axis of the nostril Measure angle  $e-g-d$  An angle exceeding 100 degrees indicates a short nose, one less than 90 degrees indicates a nose of excessive length

The profile view also best illustrates the contour of the columella and the character of the nasolabial angle Mark point  $x$  where the ala joins the lip Mark point  $y$  at the apex of the septolabial angle Ideally,  $x$  should lie at a somewhat higher level than  $y$  If it is on the same level or below that of  $y$ , either the columella is retracted or the ala is too low

Note the contour of the columella below line  $e-f$  An undue convexity with exposure of the septal lining constitutes a hanging septum Inability to see the lower edge of the columella below  $e-f$  signifies that the columella is retracted or that the alae are excessively wide or low positioned

The basal view photograph (fig 1 G and H) demonstrates The shape and symmetry of the nostrils, the width of the columella, the thickness and contour of the alae, and the breadth of the lobule and the base To analyze—

1 Draw a line,  $a-b$ , through the points where the alae join the lip 2 Draw lines  $c-d$  and  $e-f$  along the walls of the alae 3 Draw line  $g-h$ , beginning at a point midway between  $a$  and  $b$  and passing through the intersection of  $c-d$  and  $e-f$  4 Draw a line perpendicular to  $a-b$  If  $g-i$  does not coincide with  $g-h$ , it indicates a deviation of the lower cartilaginous vault, the degree being determined by angle  $i-g-h$

Observe the nostrils Ideally, they should be roughly elliptic and converge toward the tip Note their shape—whether slitlike, comma shaped, round, or irregular—their convergence and their symmetry

Observe the columella From its apex to the philtrum it should equal the height of the upper lip Its width should not exceed that of each nostril Note the flare of the mesial crura They sometimes project into the nares and interfere with respiration Observe the alae They may be delicate or puffy, round or flat, triangular, square or almond shaped Their normal height equals one-quarter that of the nose, and the interalar distance is equal to the distance between the inner canthi Excessive thickness of the alae may interfere with respiration If they are thin and nonresistant, they may collapse during inspiration

Examine the lobule, which comprises the area ventral to the nostrils It should be roughly triangular, with a rounded apex, but may be thick, thin or cleft Its width across the apexes of the nostrils is approximately three-quarters the width of the base of the nose at the level of the alar-facial junction The ventrodorsal length is one-third that of the columella

#### PHYSIOLOGY

The following account of nasal function is quoted freely from Proetz<sup>2</sup>

To render the inspired air acceptable to the lung, the nares play a fundamental role, since they regulate the volume, the pressure and the distribution of the inspired air If they are deformed, there result disturbances related to all three factors

2 Proetz, A W Applied Physiology of the Nose, St Louis, Annals Publishing Co, 1941

*Volume*—The amount of air entering the nose is largely controlled by the size of the nares, and inasmuch as the effective working of the mucosa is dependent on adequate ventilation nares too large will interfere with ventilation by admitting an excessive amount of air, and nares too small will prevent the introduction of the requisite amount.

*Adequate Pressure*—The flow of gases in the nasal chambers is dependent on pressure fluctuation set up by the thoracic excursion in combination with the constriction of the nares. The nares, being invariably somewhat smaller than the choanae govern to a large extent the pressure differentials. Mink<sup>3</sup> stated that the degree of negative pressure determines the height of the inspiratory arch (fig 2). According to Bernoulli's principle,<sup>4</sup> even minor variations in cross section result in pressure changes which cause considerable physiologic disturbance.

1 Normally the nares being slightly smaller than the choanae, produce a negative pressure of approximately minus 6 mm of water on inspiration and a positive pressure of plus 6 mm of water on expiration.

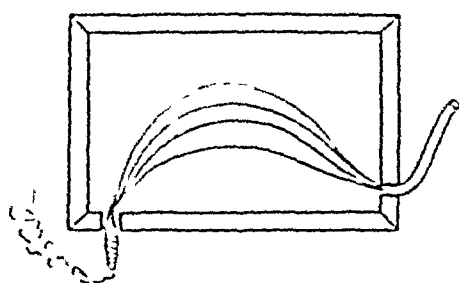


Fig 2—Diagram of a glass box with a cigar at the inlet and a pipe at the outlet, to demonstrate the effect of negative pressure on the height of the inspiratory curve (Mink's<sup>3</sup> illustration, modified)

According to Proetz, as long as the ostiums remain at all patent, the pressure changes in the sinuses are identical with those in the nose. Thus, deformity of the nares must interfere with drainage of the sinuses and its consequences. Insufficient pressure fails to make a respiratory impression and thus is unable to influence the reflexes which inaugurate the mechanism of respiration. Too great pressure has the same effect because of the obtunding influence of drying and irritation.

2 With narrowing of the nostrils, the thoracic bellows forces against the constricted nares and accentuates the negative and the positive pressure (fig 3).

3 When the nares are large, the thoracic bellows forces against the constricted choanae, and nasal pressures are quickly equalized through the large nares and only slight fluctuations take place.

<sup>3</sup> Mink, P. J. *Physiologie der oberen Luftwege*, Leipzig, F. C. W. Vogel, 1920.

<sup>4</sup> Duff, A. W. *Principles of Physics*, ed. 8, Philadelphia, The Blakiston Company, 1946.

*Distribution*—According to Proetz, it is necessary to nasal health that all portions of the nasal fossae be accessible to air currents, that they be accessible in proper proportion and that the stream of air proceed without too much eddying. Otherwise, a chain of symptoms arises marked by anosmia, headache, metaplasia and infection.

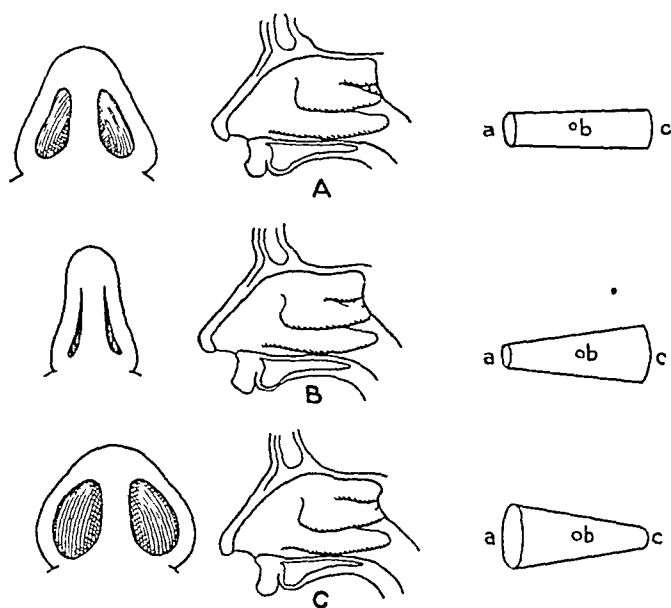


Fig 3—Control of pressure differentials by the nares. *A*, normal nares (*a*) nares, (*b*) sinuses, (*c*) choanae (See text). *B*, constricted nares, accentuating negative and positive pressures. *C*, abnormally large nares, diminishing negative and positive pressures (See text). (Proetz's<sup>2</sup> illustration redrawn.)

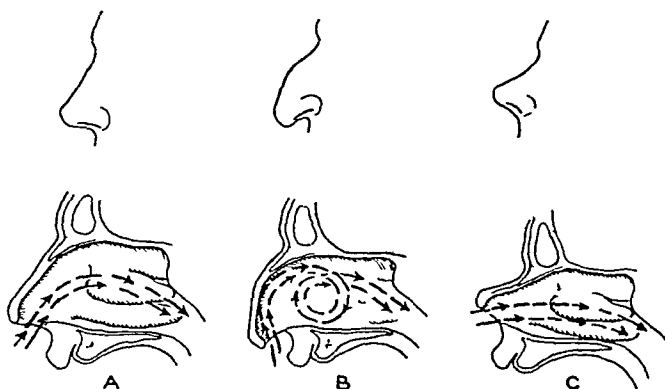


Fig 4—Inspiratory current. *A*, normal parabolic curve. *B*, impingement of the inspiratory current on the dorsum and formation of eddies in the case of dependent tip. *C*, flattening of the arch and more direct course of the current in the case of unduly elevated nares.

The inspiratory current normally takes a parabolic curve (fig 4*A*) since, the nares being dependent and the piriform opening being at a somewhat higher level, the current must necessarily arch from inlet to exit, and, as previously mentioned, the height of the current is governed

by the negative pressure. Without this arrangement, the directional effect of the nares would be lost and the currents redistributed. In the case of unduly dependent nares the inspired air impinges on the dorsum (fig 1B), and the irritation of the eddy thus created playing on the area of the anterior ethmoidal nerve may occasion reflex disturbances. Clinically, there is a localized drying out of the mucosa, also a piling up and drying of the nasal mucus, which by its irritation causes local inflammation, discomfort and pain. The bacteria in this favorable medium flourish and have a tendency to penetrate the mucosa. If on the other hand the nares are unduly elevated, the arch is flattened and the current

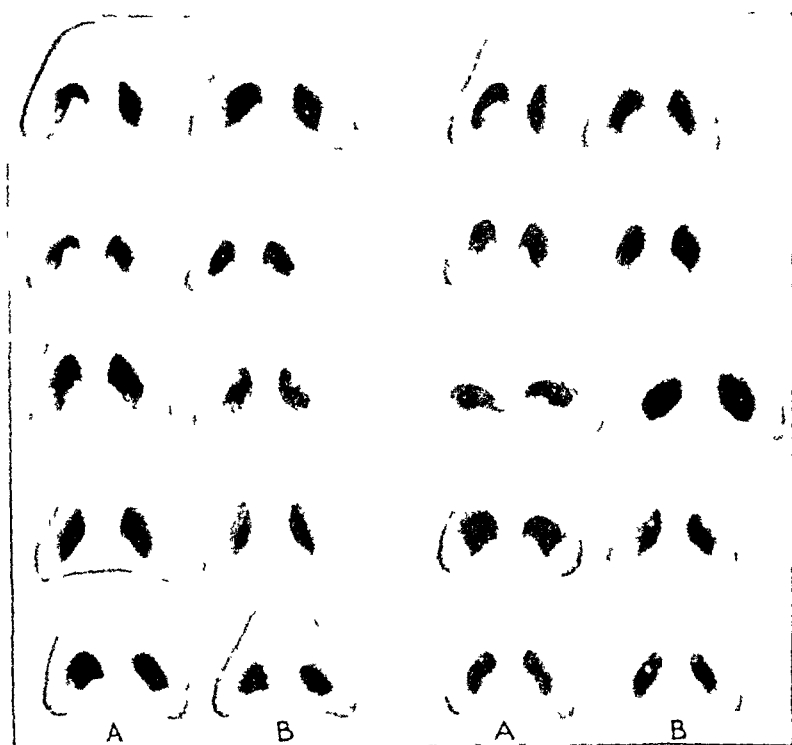


Fig 5—A, types of nares interfering with function B, restoration of function by reconstruction

takes a more direct course (fig 4 C). This also leads to drying because it interferes with the precipitation of water on expiration.

#### PATHOLOGY

The nostrils may be faulty in shape—i.e., too wide, too narrow, elongated (shitlike or collapsed), shortened or asymmetric, in size—i.e., too large or too small, in their plane of directions, i.e., tilted upward or downward, or in axis—i.e., oblique or transverse. Any or all of these faults may interfere with the volume, the pressure or the distribution of the respiratory air.

No classification can embrace the infinite variety of deformities of the nares (fig 5) But with a clear understanding of the individual abnormalities which may affect their boundaries—i e, ventral or tip, dorsal or lip, mesial or columella, and lateral or alae—the various combinations of pathologic defects can be easily integrated and the surgical correction readily planned

*Ventral Boundary (Nasal Tip)*—The nostrils are bounded ventrally by the tip, the normal contour of which is due to the graceful rounding of the angles of the lower lateral cartilages Tip deformities causing nasal abnormalities include the following

1 Wide tip usually associated with a widening of the angles of the lower lateral cartilages or to an excess of soft tissue

2 Narrow tip It usually speaks for a narrowing of the ventral pole of the nares and is caused either by a narrowing of the angles of the lower cartilages or by a deficiency of soft tissue

3 Twisted tip It is associated with asymmetric nostrils and is caused by a dislocation of the caudal end of the septum, or by hypertrophy, buckling or overlapping of the angles of the lower lateral cartilages

4 Pendulous tip It is characterized by a downward tilting of the nares in which the slant of the nares forms an angle of less than 90 degrees with the philtrum We have encountered noses in which the tip reached almost to the upper lip, and nasal respiration was possible only when the end of the nose was raised with the fingers Patients with this deformity tell of holding the tip in an elevated position during sleep by attaching it with adhesive tape to the forehead The condition is due either to an elongation of the middle or the lower cartilaginous vault or to a retraction of the septolabial angle

5 Retroussé tip This is associated with an upward tilting of the nares such that they form an angle of more than 100 degrees with the philtrum Anatomically, this is due to a short septum and short upper lateral cartilages, an upward tilting of the lower lateral cartilages or an enlarged nasal spine which widens or obliterates the nasolabial angle

6 Prominent tip This is accompanied by elongated nostrils It is due either to abnormal length of the lower lateral cartilages in an anteroposterior direction or to their being dislocated forward, or to an excess of soft tissue

7 Recessed tip causing small or negroid nares It is due to abnormal shortness of the lower lateral cartilages in the anteroposterior direction or their backward dislocation, or by shortness of the columella

*Lateral Boundaries (Alae)*—The lateral boundaries of the nares comprise the alae, whose conformation is largely controlled by the lateral crura of the lower lateral cartilages They are subject to a wide

variety of deformities. 1 As to curvature they may be convex and produce the typical rounded (flaring) nostril of the negroid type, or concave, producing narrow, or pinched, nostrils. 2 As to dimensions, they may be abnormally long, producing voluminous nostrils, or abnormally short, the size of the nostrils being proportionately smaller. 3 As to position, they may be elevated or depressed either as a matter of heredity or as a result of cicatricial contraction following trauma or disease. 4 As to width they may be so thick as to encroach on the nares or so thin as to increase their size.

*Mesial Boundaries (Columella)*—The mesial boundaries of the nares are formed by the columella, the contour of which depends largely on the flare of the mesial crura and their soft tissue investment.

The columella may be too wide producing narrow nostrils, too narrow producing wide nostrils, too short giving rise to small nostrils whose axes run from side to side, too long, and then usually associated with slitlike nostrils. The condition known as "hanging septum" occurs when the mesial crura are abnormally wide, or when the septum is too long forcing the columella below its normal level or when an abnormally long columella deforms the base of the nose by its redundancy. Retraction of the columella occurs when the septum has been dislocated posteriorly from the spines of the maxillas or has been resected to relieve obstruction, or it may occur as a sequel to excessive shortening of the nose in a rhinoplastic operation. An oblique columella results in asymmetric nostrils. Sometimes it is caused by cicatricial contraction or the agent may be a septum displaced from its position in the median line. An enlarged nasal spine and buckled mesial crura also may be responsible for columellar deformities.

*Dorsal Boundary (Nasolabial Junction)*—The nasolabial junction may be too wide or too narrow, each affecting the size of the dorsal pole of the nares. It may be recessed, as in the harelip deformity, or may protrude, as in alveolar prognathism.

#### MANAGEMENT

Seldom can defects of the nares be attributed to a single factor. They are usually the result of a combination of abnormalities about the boundaries of the nostrils. For example, the nares may be abnormally large because the columella is long and thin, the alae are long and thin or the nasolabial junction is too wide, or because of a combination of these abnormal findings. A tilting downward of the nares may be due to an elongation of the septum and the upper lateral cartilages, a retraction of the septolabial angle or a downward tilting of the lower lateral cartilages. A diagnosis of the causative factors is therefore extremely important if a good functional result is to be expected.



Obviously, the operative procedures for the correction of the deformities should be described from the standpoint of those affecting the volume, the pressure and the distribution of the respiratory current. This, however, would entail much repetition, because of the overlapping of the many causative factors. They will therefore be described in relation to the structures bounding the orifices of the nares. A knowledge of the basic procedures about to be described, together with a careful analysis, will enable one to improvise the proper treatment for any combination of structural faults.

*A Procedure Preliminary to All Corrections of the Nares Exposure of the Lower Lateral Cartilages* (fig 6) —This procedure is essential to the correction of the majority of the abnormalities described and is accomplished in the following manner:

Anesthesia is obtained with a 1.5 per cent procaine hydrochloride solution containing 1:1,000 epinephrine hydrochloride solution, 10 drops to the ounce. With a Bard-Parker no. 11 knife an incision is made along the "plica nasi" (an anatomic shelf formed by the lower margin of the upper lateral cartilage when

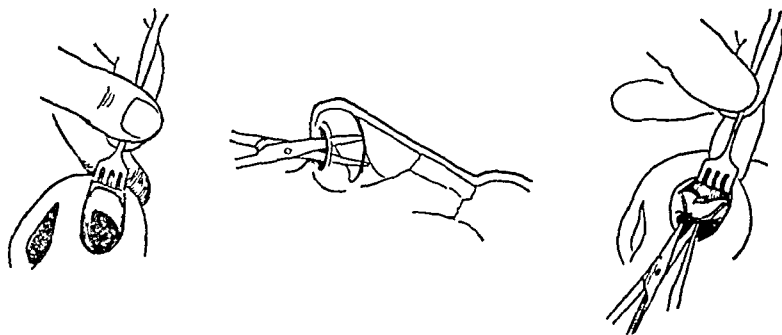


Fig 6 —Exposure of the lower lateral cartilages (See text)

the tip of the nose is elevated.) The aponeurosis connecting the upper and lower lateral cartilages is incised, the incision beginning at the center of the plica and extending ventrally to the septum. The procedure is repeated on the opposite side. A button end knife is passed from one incision to the other, and the membranous septum is cut through, the knife being held close to the caudal margin of the septum. An incision is now made in the vestibule just below the caudal (inferior) margin of the lower lateral cartilage and the procedure repeated on the opposite side. A scissors is introduced into the incision and brought out through the initial intercartilaginous incision, the instrument lying on the plane between the external skin and the cartilage. The blades are now opened and the overlying tissues separated from the cartilage. With a dural hook placed at exactly the angle of junction between the lateral and mesial crura, the cartilage is drawn out of the vestibule and divided at the angle.<sup>1b</sup> From here the modeling will depend on the objective to be achieved.

**VENTRAL BOUNDARIES OF THE NARES (CORRECTION ON THE TIP)** —The following technics were used:

*Wide Tip* —If the angles of the lower lateral cartilages are at fault, the following procedure is resorted to. The cartilages are delivered and the angles cut

through Strips of cartilage are resected from the cephalic portions (superior margins) of the lateral crura, their size depending on the degree of deformity. If the vestibules are of normal size, the resection is limited to the cartilage. If, however, they are too large, strips of vestibular skin are removed as well. The overlap between the upper and lower lateral cartilages having been lessened by the aforementioned resection, the lateral bulbousness is eliminated. Four or 5 mm. of vestibular skin is then removed from the cut ends of the lateral crura to obviate the burring of the epithelium (fig 7). The deepithelized portions are brought together over the mesial crura in the form of an inverted V. This approximation serves not only to narrow the tip but to give it a more natural appearance by projecting it slightly beyond the dorsal line.

If the width is due to an excess of soft tissue, or if the cartilages are thin, soft and lacking in resiliency, modeling of the cartilages will not suffice, excisions of tissue must be resorted to. The choice of procedure will depend on the size of the nares. If they are of normal size, two elongated ellipses of skin and subcutaneous tissue are excised from the area just above the nares, and the mir-

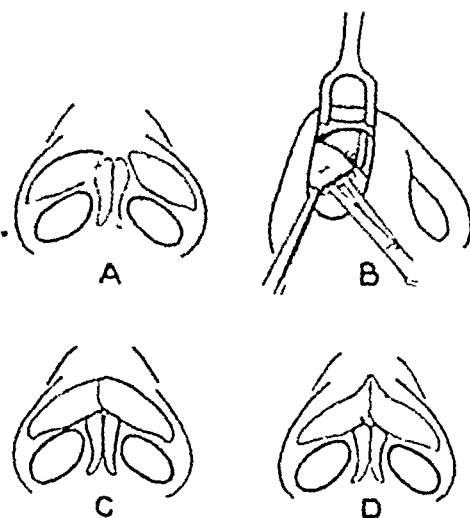


Fig 7—Narrowing the nasal tip. A, angles cut through. B, vestibular skin lining removed from the cut end of the lateral crus for a distance of 4 to 5 mm. C, deepithelized surfaces of the lateral crura overlapped. D, deepithelized surfaces brought together over the mesial crura in the form of an inverted V.

gins of the wound are approximated with atraumatic sutures (fig 8A and B). If the orifices are too large, the semilunar sections are cut in such a manner as to include a portion of the apical rim (fig 8C and D). Approximation of the raw edges will reduce not only the width of the lobule but also that of the nares. If the nares are too small, openings of normal size are outlined in methylene blue on the base of the lobule (fig 9). An incision is carried into the nares through the center of the area outlined. The subcutaneous tissue beneath the two small flaps thus outlined is dissected out and the skin rolled inward to cover the raw surfaces. The flaps are fixed in place by gauze packing of the nostrils.

**Pendulous Tip**—If the upper cartilaginous vault is at fault, it constitutes a part of the long nose deformity and the tip must be elevated. To create room for such an adjustment, triangles of cartilage must be resected from the septum and the upper lateral cartilages. Obviously, the bases of the triangles must lie on the dorsum and the apexes be directed toward the nasal spine. The technic can be found in any standard textbook. Briefly, the soft tissues of the nose are elevated,

and the membranous septum is divided in the usual manner. The upper lateral cartilages are freed from their attachments to the septum for a distance equal to the base of the triangle to be removed. The tip of the nose is raised with the finger until the nose assumes the desired length. The triangle of septum which now protrudes through the nostril represents excess cartilage and is removed with a pair of Mayo scissors. The space thus created is obliterated by fixing the columella to

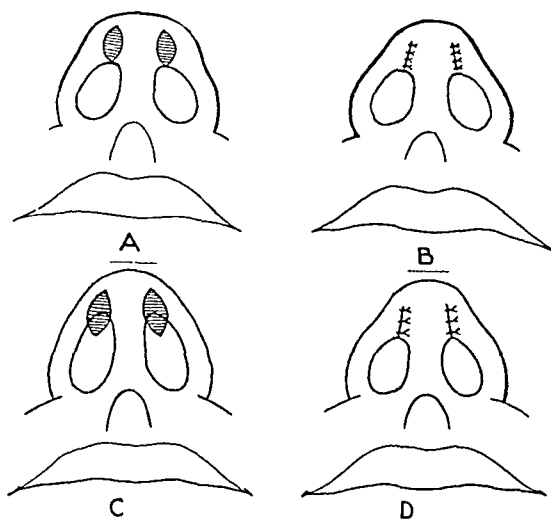


Fig 8—*A* and *B*, correction of a wide tip in a case in which the nares are normal and the excessive width is due to excess of soft tissue. *A*, elliptic portions of skin and subcutaneous tissue excised from the area above the nares, *B*, wound margins approximated. *C* and *D*, correction of wide nares (orifices too large). *C*, semilunar sections removed, including a portion of the apical rim, *D*, margins approximated.

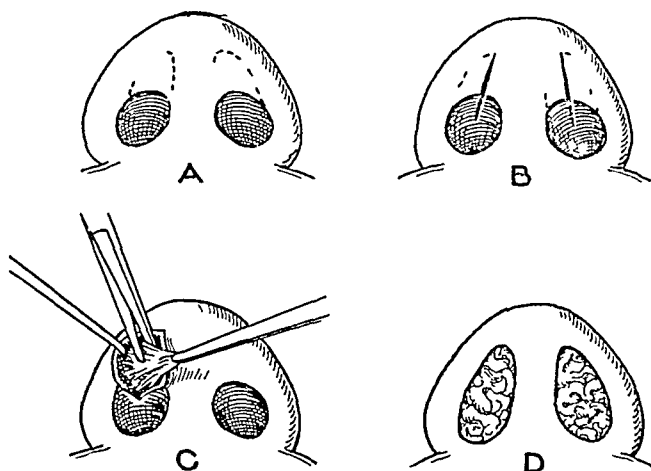


Fig 9—Correction of a wide tip with small nares. *A*, normal openings for the nares outlined in methylene blue. *B*, incision carried into the nares through the center of the area outlined. *C*, subcutaneous tissue excised. *D*, skin rolled in to cover the raw surface and held in place with petrolatum-treated gauze packs.

the septal cartilage with two strong silk sutures. This automatically causes the lower lateral cartilages to tilt upward and thus restores the normal nasolabial angle. The upper lateral cartilages, which are now too long for the shortened nose, protrude into the vestibule and are excised (fig 10).

If the dependent tip is due to abnormal width (cephalocaudal length) of the lower lateral cartilages, room is created for tilting the tip upward by excising strips from the cephalic (superior) margins of the lower lateral cartilages (fig 114)

If the lower lateral cartilages not only are too wide but also take a downward course, they create the impression, after the columella has been attached to the septum, of an overhanging tip with a retracted columella. To avoid this defect, the caudal margin of the lateral crus near the tip is rounded off. Occasion-

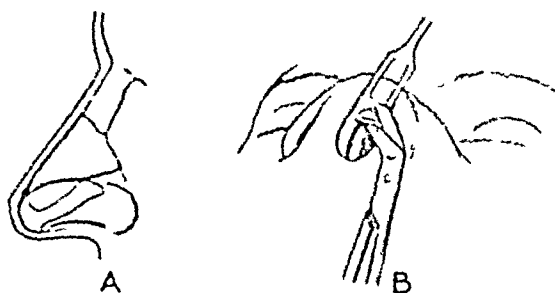


Fig 10—Excision of protruding portions of the upper lateral cartilages. A, upper lateral cartilages too long for a shortened nose. B, excision of the protruding portion.

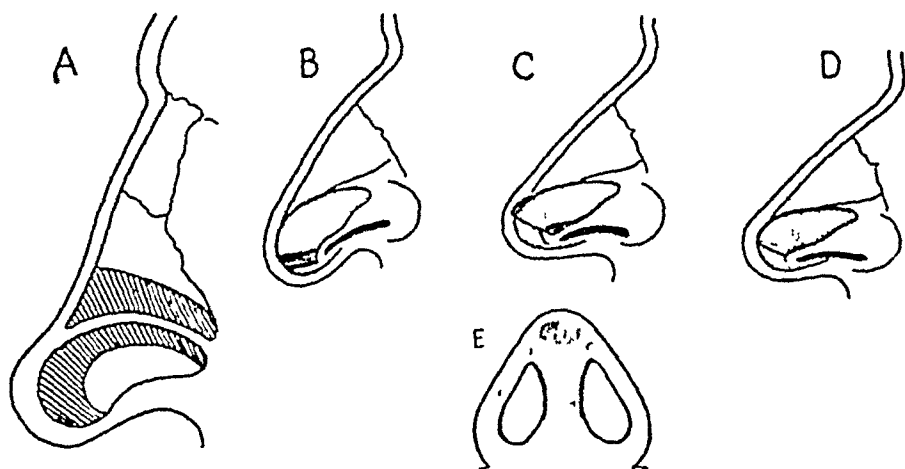


Fig 11—A, correction of a dependent tip, the deformity of which is due to abnormal size of the upper and/or the lower lateral cartilages. The shaded areas indicate the location of the cartilage to be resected to make room for elevation.

B, C and D, correction of a dependent tip, the deformity of which is due to downward displacement of the lower lateral cartilages. In B the shaded area indicates the section of cartilage to be removed. In C elevation brings the two unequal margins together. Cross-hatched areas indicate the cartilage to be trimmed. D, result of trimming.

E, modeled cartilage inserted above the mesial crura to restore the contour of the tip.

ally it is necessary to treat the cephalic margin in like manner (fig 11B, C and D). When the dome of the lower lateral cartilages is flat and thick and will not straighten out when made to override the mesial crura, the cartilage is best sacrificed and replaced with a modeled button of cartilage (fig 11E).

*Prominent Tip*—A projecting tip may be due to one of several causes. The treatment obviously will depend on the anatomic findings. If the cause is an unduly high septum, resection of the ventral border of the septum and adjacent parts of the upper lateral cartilages will allow the lower lateral cartilages to seat themselves in a more recessed position. If the abnormality is due to a forward dislocation of the cartilages, these are severed from the upper cartilaginous vault, set backward and attached to the septum in their corrected positions. If abnormal length of the cartilages is the underlying factor, the angles are delivered, cut through and resections made from the lateral and mesial crura, of a size sufficient to produce the normal projection when they fall together.

With all these deformities the soft tissue must also be carried backward, and this is accomplished by freeing the base of the nose from the alveolus, drawing it backward and maintaining it by means of a perforating suture<sup>5</sup>. One needle of a double-armed suture enters the skin of the columella and is pushed through to emerge from one of the columellar walls. It is then carried through the dorso-

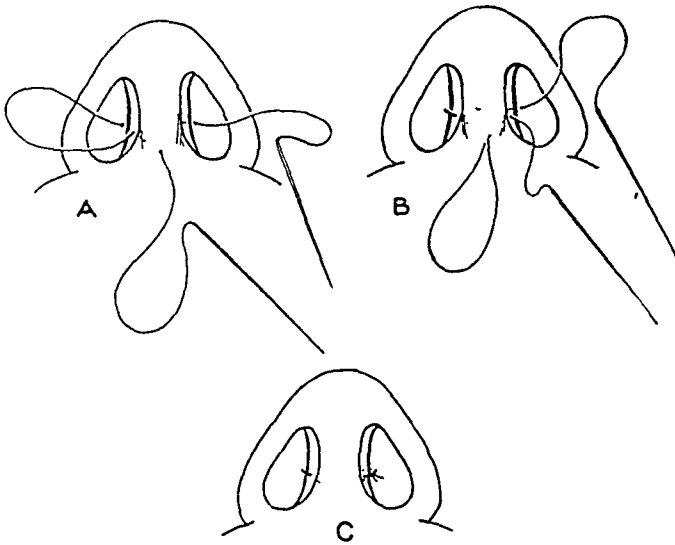


Fig. 12—Perforating suture designed to carry the tip backward (See text)

caudal (posterior-inferior) part of the septum and brought out through the nares. The other needle is carried through the original point of entry, brought out through the other columellar wall, and the ends are tied (fig. 12). It is a difficult suture to remove. Therefore, it is advisable to insert a piece of silk in the loop before it is tied.

In this deformity there is frequently a marked disproportion between the length of the philtrum and the base of the nose, the lip being abnormally short. A more balanced relationship between these two structures can be brought about by placing the perforating suture in front of the septolabial angle, i.e., in the dorsal part of the columella. When the ends are tied, the suture will draw the columellar tissues into the lip and thus lengthen it.

*Recessed Tip*—The recessed tip, like the projecting tip, may be due to one of several causes, and here, too, the success of the operative procedure will naturally depend on a correct diagnosis.

5 Daley, J. Role of Columellar and Septocolumellar Sutures in Rhinoplasty, Arch. Otolaryng. 45:178-190 (Feb.) 1947.

(1) If the deformity is due to backward dislocation of the lower lateral cartilages, the lower cartilaginous vault is separated from the upper cartilaginous vault. The lobule is brought forward and maintained in position by two sutures passed between the columella and the septum.

(2) If the deformity is due to insufficient development of the cartilages, the overlying soft tissues are freed and a button of modeled cartilage is placed above the angles of the cartilages to bring the tip forward to the proper projection (fig 11E).

(3) If the deformity is due to flaccidity of the structures forming the columella—in this case the columella is soft and bent on itself—the rigidity is restored by inserting a button of cartilage into a columellar pocket made for the purpose.

(4) If the columella is short, the following procedure is employed (fig 13). The alae are separated from the cheeks. Through these incisions the base of the nose is separated from the upper part of each maxilla, care being taken to hug

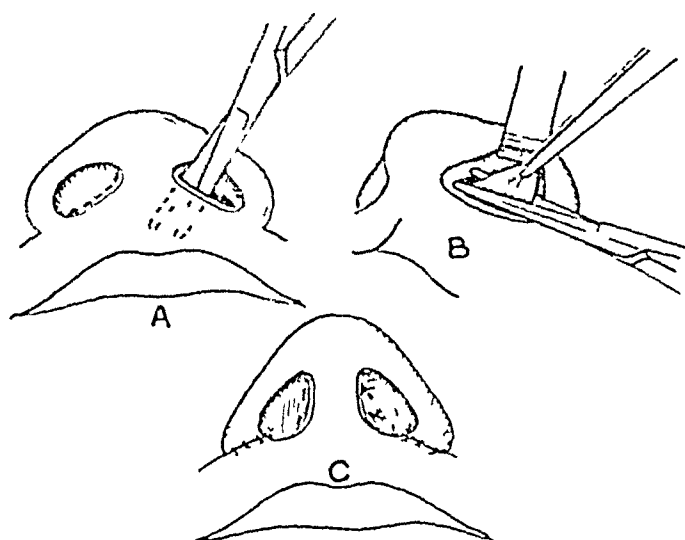


Fig 13—Lengthening of the columella. A, alae separated from the cheek, and base of the nose separated from the maxilla. B, subcutaneous tissue removed. C, mattress suture inserted to increase columellar length at the expense of labial width. Alar incision closed.

the bone with the scissors to avoid perforating into the gingivolabial sulcus. Subcutaneous tissue is removed, and a mattress suture is passed through the septo-labial angle which, when tied, will increase the columellar length at the expense of labial width. The columella is reattached to the septum in a more forward position, and the alae are then sutured back in place with atraumatic sutures.

LATERAL BOUNDARIES OF THE NARIS (CORRECTION OF THE ALAE)—Descriptions of the technics used follow.

*Long Alae*—This defect gives rise to elongated nostrils, which may be either slitlike or voluminous. In either case the technic for their correction is as follows (fig 14). The alae are pressed in to locate the alar-facial junctions and then separated from the cheeks. The alar rim is forced beneath the mesial margin of the wound until the proper configuration is obtained. While the ala is held in

this position, a mark is made on it along the line of contact, and the excess tissue is removed with a Bard-Parker knife. The wound margins are coapted with atraumatic sutures, which are left in place three or four days. The incisions having been made along natural creases, the remaining scars are barely perceptible.

*Convex Alae*—Convex alae are treated as long alae, with this difference in determining the amount of tissue to be removed (fig 15). The ala is pressed

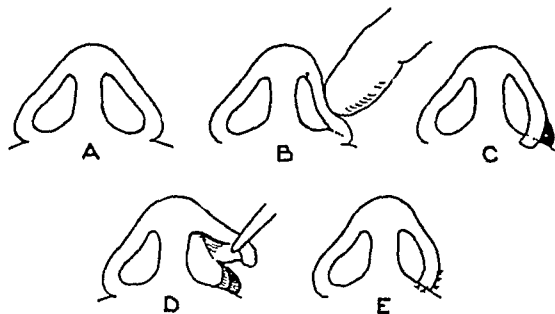


Fig 14—Reduction of long alae. A, long ala; B, ala pressed against the cheek to determine the alar-facial junction; C, ala forced beneath the medial margin of the wound to secure the proper configuration, and excess tissue marked out; D, excess tissue removed; E, reduced ala reattached.

inward with the finger until the convexity disappears. The line of contact between the ala and the base of the nostril is marked out, the semilunar portion of skin lying between this line and the alar-facial groove is removed.

*Thick Alae*—Thick alae are corrected in the following manner (fig 16). The alae are separated from the cheeks along the alar-facial grooves. The cut edge shows a fatty pad between the vestibular and the external skin, definitely demarcated. This fatty wedge is removed with a no. 11 Bard-Parker knife, and the skin surfaces are brought together with a suture, the ends of which are tied

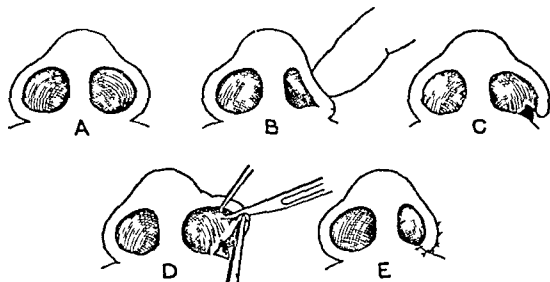


Fig 15—Reduction of convex alae. A, deformity; B, ala pressed in with the finger until the convexity disappears; C, ala cut through at the point of angulation; D, excess tissue removed; E, wound margins coapted with atraumatic sutures.

inside the vestibule. The suture is so passed that it is returned through the same skin opening through which it was brought out, thus obviating any danger of surface scarring.

Subcutaneous tissue may be removed similarly from the wound margins on the cheek and the lip. This will serve to equalize the raw surfaces which are to be approximated.

*Bulging of Lateral Crura into the Vestibule*—Here the lateral crura of the lower lateral cartilages bow inward so as to encroach on the lumens of the nares. The bowing is usually manifested externally by a deepening of the alar groove, which gives the nose a pinched appearance.

An incision is made in the vestibule along the caudal margin of the bowed cartilage, and the soft structures above the cartilage are elevated. The cartilage is

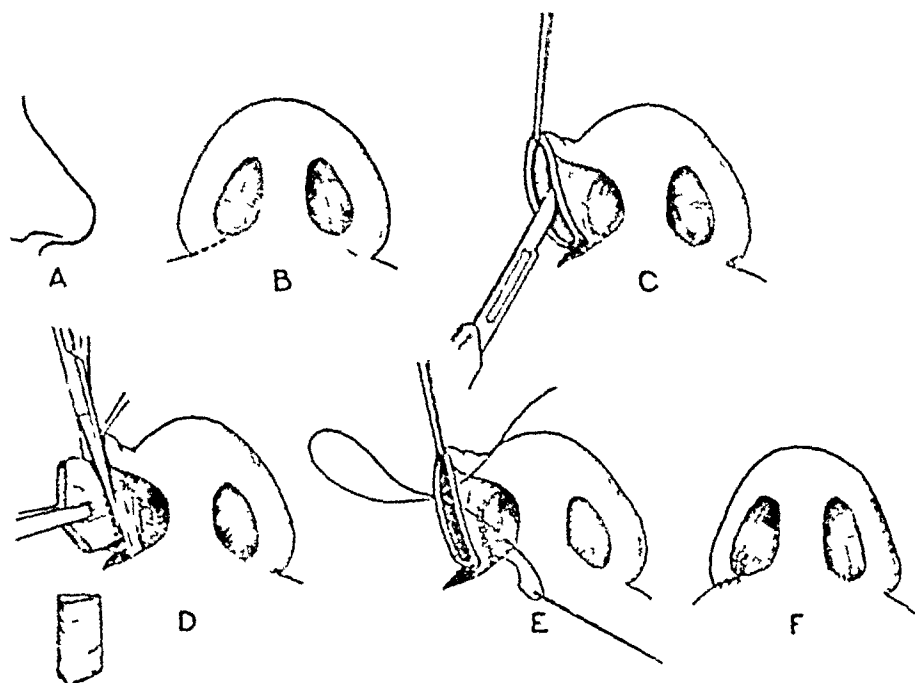


Fig 16—Reduction of thick alae. *A* and *B*, alae separated from the cheeks along the alar-facial grooves. *C*, sharp dissection of the fatty pad between the skin layers. *D*, resection of the fatty wedge. *E*, edges of the skin brought together with a silk suture so passed that the loop disappears beneath the cutaneous surface. *F*, alae reattached.

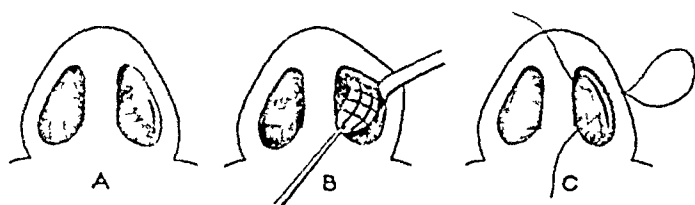


Fig 17—Correction of inward bulging of the lateral crura. *A*, incision made in the vestibule along the caudal margin of the bowed cartilage. *B*, lateral crus delivered and cross-hatched. *C*, vestibular skin attached to the outside skin by a perforating suture.

cross-hatched or parts are excised, and the vestibular skin is fixed to the outside skin by a perforating suture tied on the vestibule surface (fig 17).

*Flat Alae*—Flat alae constitute a part of the harelip deformity and are corrected as follows (fig 18). The osseous and upper cartilaginous vaults are reconstructed according to the technic employed in a typical rhinoplasty. The lower lateral cartilages are completely mobilized. The affected ala is separated from the cheek along the alar-facial groove and is thinned out in the manner described under



"Thick Alae" A perforating suture is passed as previously described, and in such a manner as to take up the redundant vestibular skin. A pocket is made in the columella, and a batten of cartilage is introduced. The two sides are twisted between the thumb and the forefinger so as to swing the short side upward to the level of the long side. The parts are maintained in the corrected position by two mattress sutures passing through the batten. If the base of the nose is depressed, it is elevated at this time by a cartilage batten, introduced through the wound created by elevation of the ala. Additional grafts may be necessary.

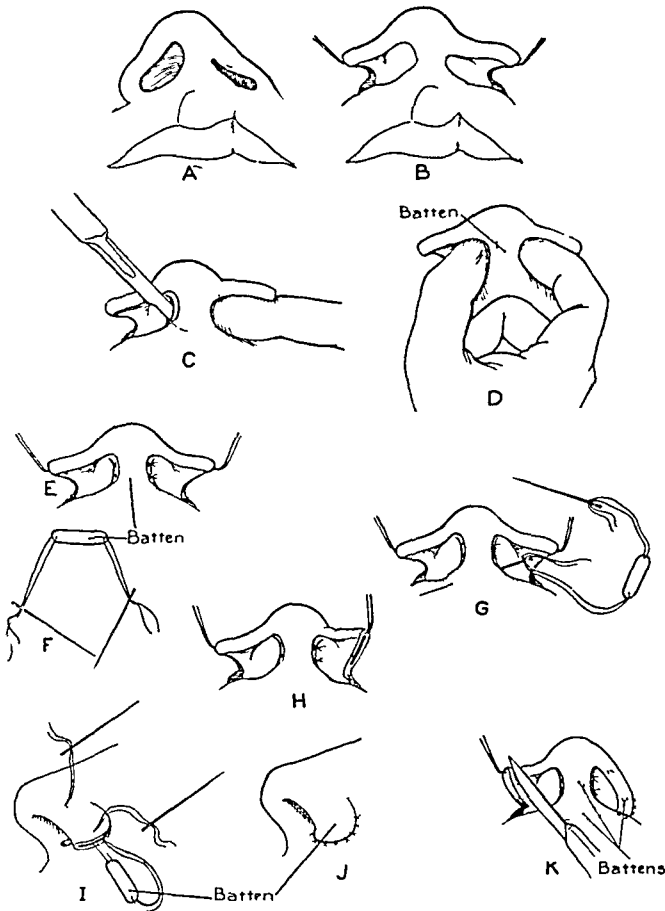


Fig 18—Correction of flat alae. *A*, lower lateral cartilages completely mobilized (Refer to figure 5). *B*, alae separated from the cheeks along the alar-facial grooves and thinned out as in figure 15. *C*, pocket made in the columella. *D*, cartilage batten put in place and the short side swung to the level of the long side by twisting motion. *E*, parts maintained in the correct position by two mattress sutures passed through the batten. *F*, pilot suture passed through batten. *G*, pilot sutures passed through lip. *H*, graft in place. *I* and *J*, alar margins stiffened by additional grafts. *K*, normal ala made to match the corrected side.

to stiffen the alar margins. Finally, the ala is rotated inward and reattached to the lip with atraumatic sutures. The normal ala is reconstructed to match the corrected one.

*Abnormal Elevation of the Lateral Crura*—Here the lateral crura, instead of running parallel to the nares, tilt upward, the fault being characterized externally by a facet on the alar rim.

The lower lateral cartilages are delivered (fig 19). The lateral crus is freed from its outer and vestibular skin investments. A suture is passed through the terminal end of the cartilage. The free end of the suture thread is passed through the eye of the needle. The needle, now holding both ends of the suture thread, is passed into the pocket created by the liberation of the cartilage and then is brought out on the surface at the point where the lateral crus is to be relocated. Traction is made, drawing the crus into the desired position, and an atraumatic suture is passed through the vestibular skin and the cartilage to hold it in place.

**MEDIAL BOUNDARIES OF THE NARIS (CORRECTION OF THE COLUMELLA)**—The methods used were as follows:

*Thick Columella*—If the columella is too thick because of excessive soft tissue or because of too much flaring of the extremities of the mesial crura, in-

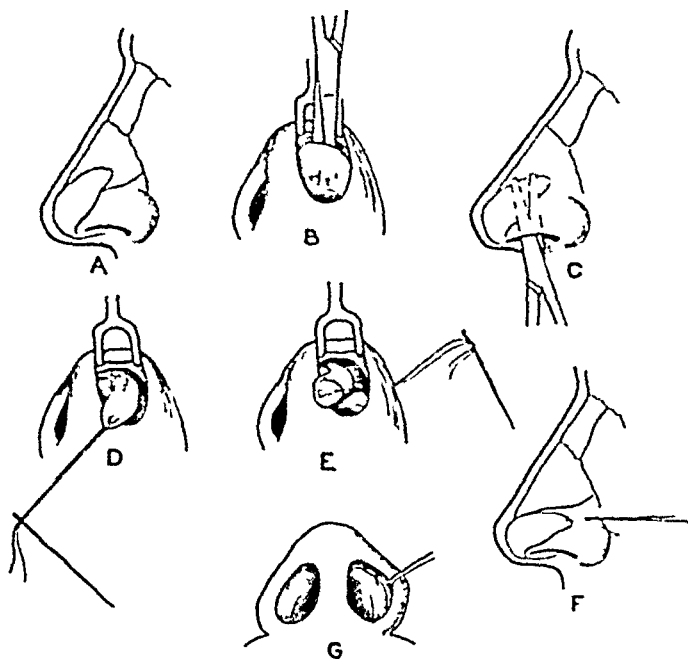


Fig 19—Correction of abnormal elevation of the lateral crura. A, position of the lateral crus. B, vestibular skin separated from the lateral crus. C, outer skin separated. D, lateral end of cartilage drawn out and suture passed. The needle contains both ends of suture thread. E, needle passed into the pocket created by liberation of cartilage and the suture brought out on the surface where the lateral crus is to be relocated. F, crus drawn down to the desired position by traction on suture. G, cartilage held in place by atraumatic suture.

cisions are made along the cephalic margins of the mesial crura and the excess subcutaneous tissue and cartilage are excised (fig 20). The mesial crura are then sutured together with black silk. This will result in an improved airway, for the size of the nares has been increased.

*Long Columella*—Although we have performed rhinoplasty several thousand times, we have never once had to excise the redundancy of a long columella externally. When the lower lateral cartilages have been completely mobilized and reduced, the skin adapts itself readily. Any excess may be thrown into the lip by resorting to the perforating suture previously described (fig 12).

*Short Columella*—The elongation of a short columella has already been described under "Recessed Tip" (fig 13)

*Retracted Columella*—This deformity is usually due to a dislocation of the caudal end of the septum, to a sacrifice of the caudal portion in a case of obstructing septum, or to excessive shortening of the septum in a rhinoplastic operation. The method of correction will depend on the cause and on the presence or the absence of a membranous septum.

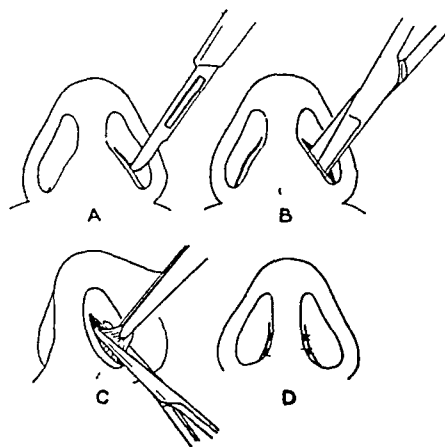


Fig 20—Correction of a thick columella. *A*, incisions made along the cephalic margins of the mesial crura. *B*, columellar skin separated from the underlying structures. *C*, excess tissue removed. *D*, mesial crura united with mattress sutures of black silk.

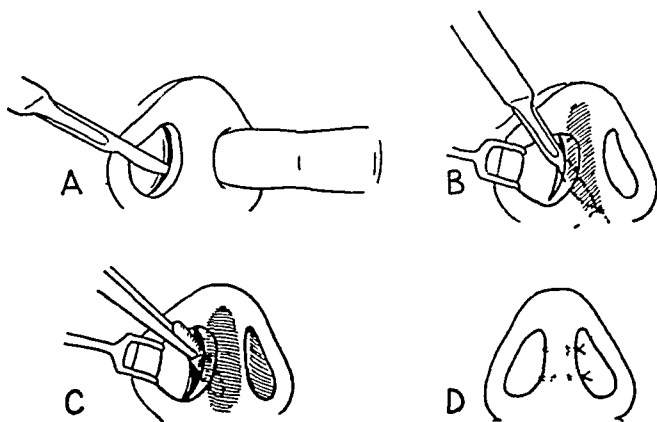


Fig 21—Correction of retracted columella. *A*, membranous septum incised, the index finger protecting the opposite wall against perforation. *B*, bed prepared in columella for reception of a graft. *C*, columellar graft inserted into the prepared pocket. *D*, graft held in place by sutures passed behind it.

When it is due to a displaced septum, the retraction disappears as soon as the septum has been restored to its sagittal position. When excessive shortening is the cause, a unilateral incision is made in the membranous septum, through which a bed is created and a batten of cartilage introduced (fig 21). In cases in which there is insufficient membrane left to enclose the batten, membrane is borrowed from the septum as follows (fig 22). The membrane on one side

of the septal cartilage is incised 5 to 6 mm cephalward and parallel to the caudal margin of the septum. The membrane is freed from above down. That on the opposite side is similarly treated. Between the two layers of the newly made membranous septum a batten of cartilage is implanted and is fixed in place by two mattress sutures passed through the displaced membranes.

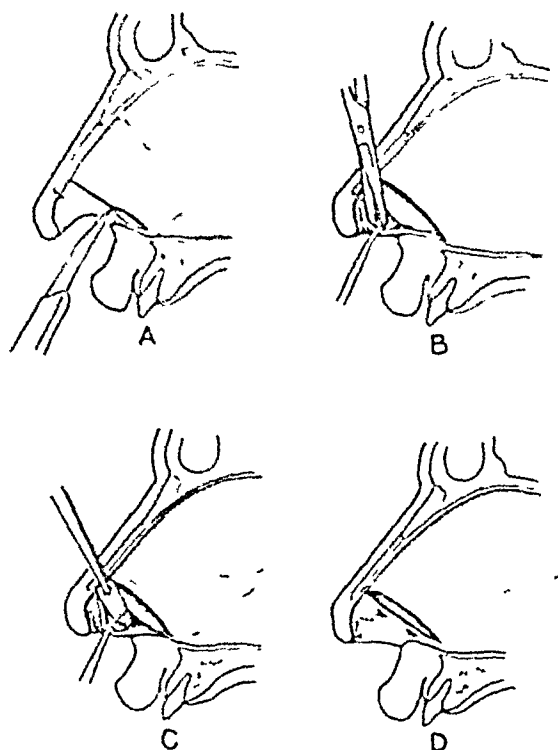


Fig. 22—Correction of retracted columella with deficient membranous septum. A, incision made in the mucoperichondrium above the caudal margin of the septum. B, membrane freed below the incision. C, batten of cartilage implanted in the pocket. D, cartilage graft fixed in place with two mattress sutures.

#### SUMMARY

An attempt is made to rationalize the surgical correction of abnormalities of the nares from a functional standpoint and to show that rhinoplasty should be considered an integral part of present day rhinology. The clinical anatomy, physiology and pathology of the nares are reviewed.

The corrective surgical procedures described in this article have been developed in our clinic. They will help restore normal volume, pressure and distribution of respiratory air. Frequently the procedures serve as adjuncts to septal surgery in the restoration of function. It is felt that many technically perfect submucous resections of the septum have failed to restore normal nasal respiration because the necessary surgical correction of the nares was neglected.

## ELONGATED STYLOID PROCESS

Further Observations and a New Syndrome

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DURHAM, N. C.

IN 1937 I<sup>1</sup> presented the first case of clinical symptoms due to an elongated styloid process observed in the clinic of the division of otolaryngology of the department of surgery of Duke University School of Medicine. At that time I reported 2 cases in which there had been surgical shortening of the elongated process and 2 cases in which there had not been an operation of this type. In 1940 a series of 43 private cases with a diagnosis of elongated styloid process was reported from our clinic by Fritz,<sup>2</sup> which included the 4 previously mentioned cases. From 1940 to December 1946 we have observed 211 additional cases on the private service at Duke Hospital, making a total of 254 cases, an average of 35 each year on the private service alone. There has been a total of 44 operations on these private patients, for shortening of the styloid processes. The condition is diagnosed with less frequency in the public dispensary than in the private clinic, owing to the failure to perform routine palpation of the pharynx and to the fact that the number of Negro patients having tonsillectomy, with the ensuing symptoms, is small. The Negro race probably has proportionately more elongated styloid processes than the white race, but such styloid processes are more often found in anatomic dissecting rooms.

In view of the frequency of the severity of the clinical symptoms my colleagues and I consider the subject of elongated styloid process worthy of still further reports. Even now the disease is not recognized or treated by many otolaryngologists. This is not surprising, because nine of ten of the newer editions of textbooks in the field of otolaryn-

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1. Eagle, W. W. Elongated Styloid Processes. Report of Two Cases, *Arch Otolaryng* **25**:584 (May) 1937.

2. Fritz, M. Elongated Styloid Process. Cause of Obscure Throat Symptoms, *Arch Otolaryng* **31**:911 (June) 1940.

gology do not even include the disease. These facts have doubled our efforts to accentuate and stimulate the interest of otolaryngologists in the subject. In addition to the usual symptom complex, which was previously described, another syndrome is presented, which we believe may be traced directly to an elongated styloid process.

Begging indulgence, I should like to describe my first clinical experience with an elongated styloid process. In 1955, we saw once again a patient whom we had seen over a five year period at fairly frequent intervals, who had complained of pain in the left side of her throat and pain in the left ear, with the pains being more severe on swallowing. The tonsils had been removed eight years prior to her first visit or thirteen years previously. She always had the sensation that her throat had never healed after the tonsillar operation. Needless to say, she had returned many times to the specialist who had removed her tonsils and had also visited numerous other otolaryngologists. She was considered to be a neurotic person by each of us who had observed her, because at no time were any of us ever able to see anything wrong in her throat. Finally, in 1955, thinking "she may have a foreign body, such as a toothbrush bristle or a fishbone, in the mucosa of the pharynx or the hypopharynx, which can not be seen, even with a laryngeal mirror," I decided to palpate the pharynx. To my surprise I did palpate something firm in the left tonsillar fossa, which was not palpable likewise in the right tonsillar fossa. The left fossa was extremely tender on palpation, and the palpation reproduced the pain in the pharynx and the left ear of which she had been complaining. A skull was studied, and, with the mandible wide open, it was evident that only a styloid process could have been palpated in the left tonsillar fossa. During my studies of anatomy I had seen and dissected a styloid process, but throughout the intervening years I had lost all memory of the styloid process, as there had never been any clinical significance of the styloid process in my practice. The literature was then reviewed, and I was amazed to find that little had been published on clinical symptoms referable to the elongated styloid process. Most of the articles were found in anatomic journals, and in these articles the condition was considered as an anatomic curiosity. The patient previously referred to was then told of her probable condition. She submitted to a surgical shortening of the left styloid process, and immediately there was complete alleviation of all her symptoms.

It is not necessary or important that I review here the historical background of the clinical recognition of the elongated styloid process. This was reviewed in my previous presentation.<sup>1</sup> I do wish to emphasize, however, that patients having symptoms as in the case just described have in each instance undergone tonsillectomy, and the

symptoms immediately followed the operation. The other syndrome which I shall describe is atypical and may occur in patients who have or have not had their tonsils removed.

Patients are now classified into two groups—first, those patients exhibiting the typical syndrome as in the case just cited, second, those patients having pain beginning in the neck, which follows the distribution of the carotid artery, either the external or the internal branch, usually the external branch. The carotid artery syndrome, I believe, is due to the elongated process that points either medially, causing pressure and some obstruction of the internal carotid artery, or laterally, thereby impinging on and impairing the circulation in the external carotid artery. In either instance, pain follows the distribution of the artery.

#### SYMPTOMS

*Typical Syndrome*—The characteristic symptoms are a constant pain or a nagging dull ache in the pharynx, presenting the sensation that the throat did not heal after tonsillectomy, a pain frequently referred to the ear, indicating irritation of the vagus nerve, increased salivation, hesitancy and difficulty in swallowing, gagging, a sensation of a foreign body—even cotton—in the pharynx. These symptoms may be wrongly diagnosed as due to glossopharyngeal neuralgia, but when analyzed they do not fit in with true glossopharyngeal neuralgia, since in that disease one deals with neuralgia of extreme severity, usually lancinating and of momentary duration, but recurrent and frequently stimulated by intake of hot or cold stimuli, such as food or drink, and sometimes stimulated by even the slightest movements of the tongue. The pains due to elongated styloid processes are constantly nagging but rarely severe.

The group of cases presenting the typical syndrome also includes all cases in which there is distortion of nerve function involving the sensory and motor fibers of the fifth, seventh, ninth and tenth cranial nerves. The sensation of taste may be quite distorted. A spasm or contraction of the constrictor muscles of the esophagus and the pharynx may be observed. One patient having spasm of the constrictor muscles was caused much embarrassment each time he attempted to eat. Shortening of his elongated processes allowed him to eat normally.

Patients having typical symptoms due to an elongated process, I repeat, are those who have undergone tonsillectomy and whose symptoms arise during the post-tonsillectomy convalescence. Scar tissue formation stretching the nerve endings is thought to be the cause of the symptoms. The ninth cranial nerve is most often affected, with occasional fifth nerve, and rare seventh and tenth nerve involvements. The tautness of the pharyngeal mucosa over the process can easily

stimulate these nerve endings as movements of the pharynx occur. In 1 case I noted the pharyngeal mucosa suspended as if on a tent pole, and when the patient gagged, the mucosa of the pharynx visibly glided over the tip of the process, each movement causing pain. The typical syndrome is found when the elongated process points straight forward or medially—the usual direction.

I do not infer that all elongated styloid processes become symptomatic, for many an elongated process is found on routine palpation of the pharynx when the patient is complaining of no local symptoms whatever. Certainly, operation is not recommended unless the elongated process is causing severe symptoms.

*Carotid Artery Syndrome*—In August 1916 I had the first data to substantiate an idea which I had entertained for six years that an elongated styloid process might produce pains along the carotid artery distribution. Since 1910 I had encountered patients, probably 12 in all, who had complained of pain beginning in the neck at a point about opposite the tonsillar fossa, which extended upward over the side of the head in a pattern conforming to the distribution of the external or the internal carotid artery. I had made notes that probably a carotid artery was involved in these cases in some way, but I had no definite evidence of this.

Mrs. S., aged 67, was first seen in May 1916, complaining of a pain of many years' duration throughout the left side of her head, beginning in the neck, and the pain was in a perfect pattern of the external carotid artery distribution. She was found to have elongated styloid processes, but the left one only was tender on palpation beneath the tonsil, which were still present. Since all other examinations gave entirely negative results, the consultants decided that the left styloid process should be shortened, and in August 1916 the patient returned for the operation. After the left tonsil was removed, the left styloid process was found deviated or hooked at the tip and firmly embedded against the external carotid artery, restricting its lumen. She had an uneventful convalescence and to the present date has been relieved of her symptoms. (It is of interest to note that she has a sister who also has a bilateral elongated process, which in her case is asymptomatic.)

This case is the first and only one of the group of cases of suspected carotid artery syndrome in which the patient underwent operation, and thus allowed substantiation of the existence of the carotid artery syndrome. There were other operative cases in which the carotid artery was very superficial, owing to its being elevated laterally by the elongated process, but there was little impingement on the arterial lumen in any of these cases. From the single case cited, it is impossible to conclude too decisively that the other patients in this group had the same basic condition—that is, obstruction to the arterial function and symptoms of pressure on the sympathetic nerves of the arterial walls. The findings at operation are more conclusive than the result of roentgenologic examination and other diagnostic procedures.



Further operations must be done in such cases to establish the syndrome definitely. The posterior-anterior roentgenogram is essential to demonstrate deviations at the tip of an elongated process, but even so they do not demonstrate whether the tip of the process actually cuts into the path of a carotid artery. Occasionally an elongated process resembles a ram's horn (fig 1), curving on its own axis, which is easily shown in the lateral roentgenogram. In any case suspected to be one of the carotid artery syndrome posterior-anterior, as well as lateral, roentgenograms should be made.

Tinnitus is occasionally complained of by patients having the carotid artery syndrome. One patient had annoying tinnitus, which was almost unbearable when the styloid processes were palpated. This



Fig 1—Ram's horn type of elongated styloid process

aggravation of tinnitus may seem difficult to explain, since the basilar artery, which is a continuation of the vertebral artery and not of the carotid artery, is the only artery supplying the cochlea. The case is similar to one of vascular tinnitus in which there is no elongation of the styloid process, in that the tinnitus is transmitted to the cochlea through the bone.

A pain in one or both sides of the neck may cause a person to consult a physician, and the examiner may find only a superficial and pulsating carotid artery. Frequently this may be the internal carotid

artery, for the textbooks of anatomy relate that just above the bifurcation the internal carotid artery is more external than the external carotid artery itself. In some cases it is superficial and painful on palpation because it is elevated to its position by an underlying elongated and outward deviating styloid process. (The tip of a process of normal length lies between the two arteries.) In addition, the patient may have increased his symptoms by continually bruising that portion of the cervical region by palpation. A prominent vessel may be mistaken for a cervical lymph node especially if it is tender. A cervical node overlying a carotid vessel is always quite painful because of the sympathetic sensory nerve supply in the wall of the carotid vessel.

I believe that an elongated styloid process which fits so tightly against a carotid artery as to impair its circulation may cause the carotid artery syndrome. I now wonder and even suspect that many patients are treated for migraine, histamine sensitivity, temporal artery and other vascular headache, or atypical headaches and neuralgias, when in reality they may have an elongated styloid process. It is conceivable that even a styloid process of normal length may cause symptoms if there are anatomic malarrangements and variations in the cervical region. These anatomic variations and the relations of structures in the styloid area, the function of the three styloid muscles and other anatomic facts are under investigation for a future report.

#### DIAGNOSIS

The diagnosis of elongated styloid process should be facilitated by the patient's history. It is confirmed by the palpating finger. When the tonsils have been removed, there is no question of the diagnosis if a firm bony resistance is met in the tonsillar fossa, especially at the upper pole of the fossa (fig 2). If a styloid process is palpable, it is always elongated. The normal length of the styloid process is 1 inch (2.5 cm), and the normal process can never be palpated, since it lies just that deeply in the parapharyngeal musculature. When a styloid process is symptomatic, the patient will wince from pain as the process is palpated, and he will state that the pain is the same as that of which he has complained. The elongated process may be palpated through and beneath some tonsils. Roentgenograms are taken merely for confirmation of the diagnosis but are later used as a guide, and are of considerable aid, in the surgical shortening of the process.

The actual length of the elongated process is determined on the lateral roentgenogram, which also allows the surgeon to determine just how much of the process should be removed at the operation (fig 3). The posterior-anterior view (fig 4A) shows any deviation of

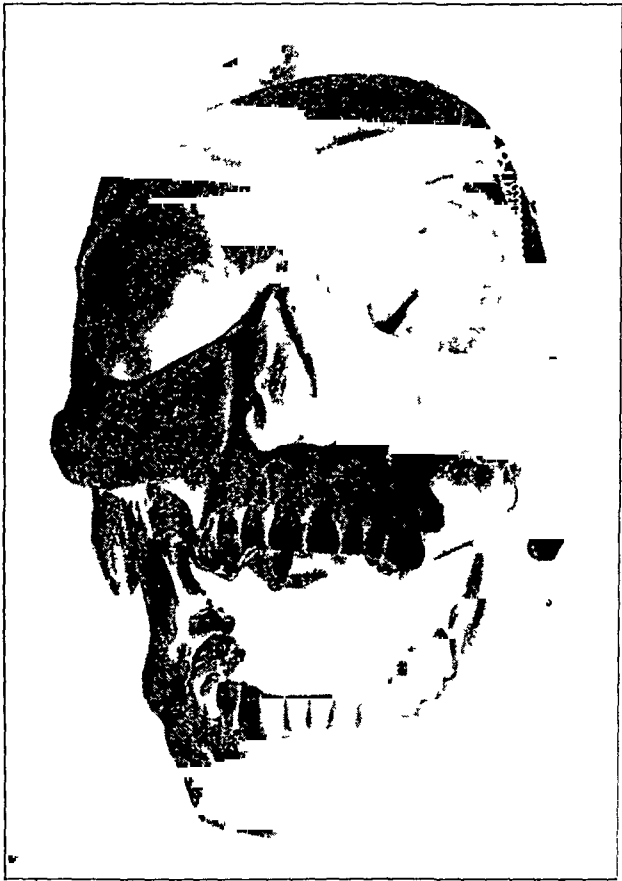


Fig 2—The ease with which the elongated styloid process of the right side can be palpated is demonstrated here The proximity of the styloid process to the mandible is also to be noted

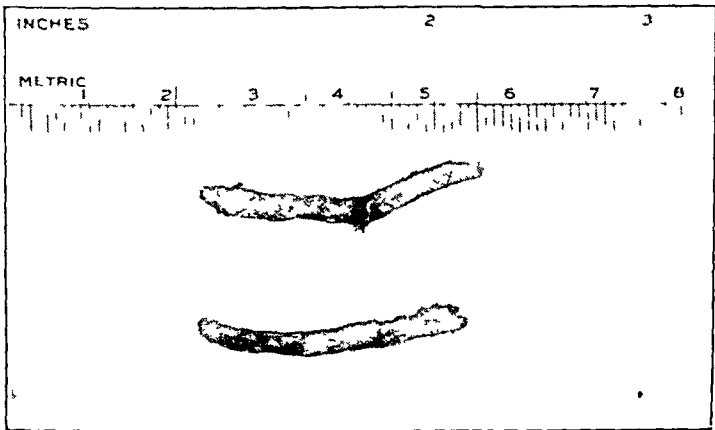


Fig 3—Removed elongated styloid processes Note the curvature of the upper specimen A styloid process of this type may project against a carotid artery

the entire process, including the tip, which cannot be recognized in the lateral view

#### TREATMENT

The treatment of the elongated styloid process is entirely surgical. Simple digital fracture of the process, experience has shown, does not alleviate the symptoms. Uniformly good results have been obtained by the surgical shortening of the process in all our patients.

The operation for shortening the elongated styloid process is difficult to the extent that one does not have the visualization that is obtained in other operative fields, and the operator must depend to a certain extent on use of the index finger, as well as that of instruments, for the dissection.

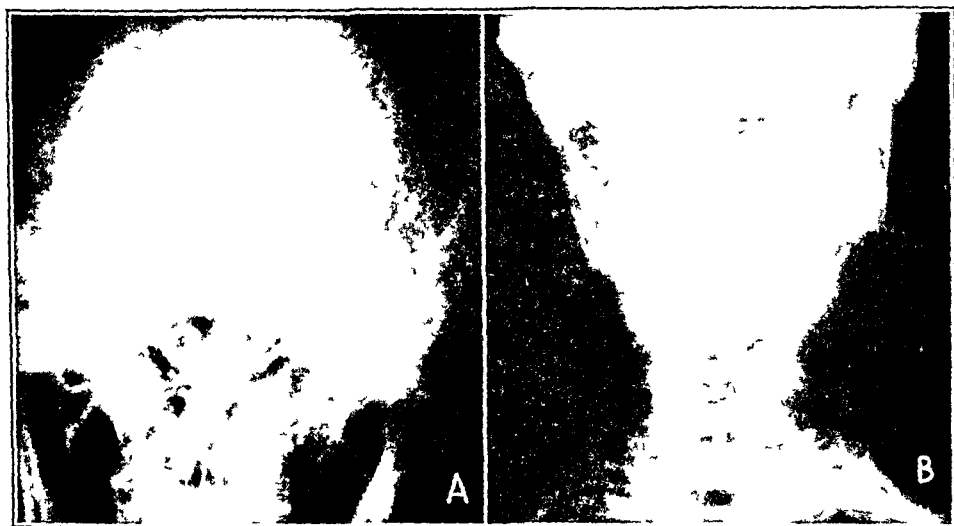


Fig 4—In *A* an elongated styloid process is seen on each side. These processes are quite large also.

*B* shows an elongated styloid process on the left side and a process of normal length on the right side.

Figure 5 illustrates the operation. An incision is made in the tonsillar fossa over the tip of the palpable elongated process. The incision is spread with scissors or a clamp until the tip of the styloid process is palpable through the incision. The muscles attached to the medial surface of the process are stripped by the finger. A curved instrument, such as a submucous resection elevator, is used to free the muscles from the lateral and posterior portion of the process. Very little force may be used during the dissection, lest the process be fractured prematurely. After the muscular stripping, the styloid process stands out as a white, ivory-appearing rod, usually the caliber of a safety match. The stylohyoid ligament at the tip of the process is easily visualized and palpated during the dissection and is now severed.

with scissors, unless it is calcified. This maneuver provides easier access for the finger and the instruments to strip any remaining muscular attachments from the posterior and lateral surface of the process. The length of the portion which is to be removed has been determined prior to operation by study of roentgenograms. The actual fracturing of the portion to be removed is accomplished with the Hajek forceps. A curved clamp must have already grasped the distal end of the process to prevent its retraction into the muscles should there be attachments remaining. In removing the fragment by means of this clamp, one must exercise care with regard to the external and internal carotid arteries and the facial nerve, which emerges from the skull posteriorly.

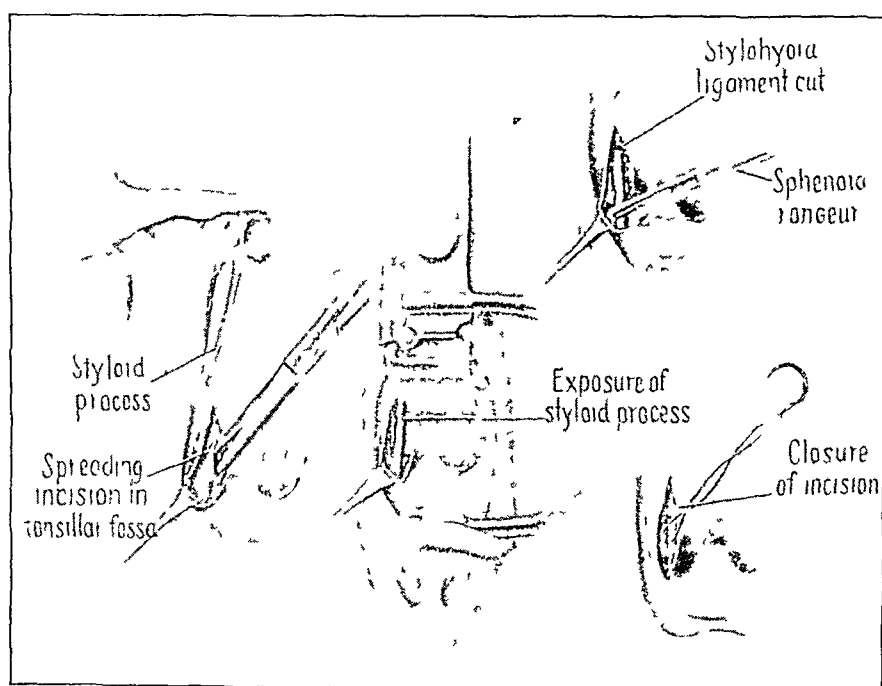


Fig 5—The various stages of the intraoral shortening of the elongated styloid process. General anesthesia and the Crowe Davis mouth gag are used. Sulfanilamide is left in the wound before closure.

to the base of the process. The styloid stump is then palpated to determine whether it is too long, and usually it is not. Sulfanilamide is then placed in the wound, and the incision of the tonsillar fossa is closed with no. 0 plain catgut sutures. There is usually no bleeding of significance during the operation, and in our experience hemorrhage has never occurred postoperatively. Edema of the tonsillar fossa is usually mild, and the convalescence is unusually much easier than that following tonsillectomy. This apparently is due to the complete closure of the wound and the action of the sulfanilamide inserted in the wound, preventing infection.

Loeser and Cardwell<sup>3</sup> in 1942 devised another operation to shorten the elongated styloid process. They make a V-shaped incision beneath the mandible, extending it down the anterior border of the sternocleidomastoid muscle. Their operation requires that the contents of the carotid sheath and the other deep structures of the neck be pulled forward in order to expose the styloid process. We are not convinced that the external route is the easier or the more rational method of surgical procedure, and we do not see the necessity of the visible scar which will be present postoperatively in the neck. Furthermore, the fact that the palpating finger locates the process in the tonsillar fossa makes it seem logical that the surgical procedure is an intraoral one.

#### COMPLICATIONS

There are no complications as such of cases of symptomatic elongated styloid process other than the continuance and increased severity of symptoms. Postoperatively the complications are minimal and actually negligible. There had been no complications of any kind in any of our operative cases until November 1946, when 1 patient had tremendous edema of the neck on each side following bilateral operation. The edema lasted five days and was considered as due to sulfonamide drug sensitivity, the sulfanilamide having been left in the wound. There was no intrapharyngeal swelling in the patient. As a matter of fact, no more edema is noted after surgical shortening of an elongated styloid process than after any other type of pharyngeal surgery. Respiratory distress has never been noted. Patients are usually able to eat well by the third day and are allowed to leave the hospital on the third or fourth postoperative day. In no instance has the facial nerve or a carotid artery been injured.

#### RESULTS

When the elongated styloid process is surgically shortened, the results are uniformly excellent and permanent. The elongated portion of the styloid process must be fully shortened, with removal of the fragment, to alleviate all symptoms. There have been 2 cases in which the fragment was pulled back into the musculature by some muscles still attached to the process, and the fragments were never recovered, one of the patients still had mild symptoms one year after the operation when last heard from, and the other was operated on only a few months ago, so far without report of trouble. In 1 case in which the styloid process projected parallel to the cervical spine, fracturing was

<sup>3</sup> Loeser, L. H., and Cardwell, E. P. Elongated Styloid Process. Cause of Glossopharyngeal Neuralgia, *Arch. Otolaryng.* **36**: 198 (Aug.) 1942.

done only because of the odd position of the process. The patient still had mild symptoms two years later when last heard from.

#### SUMMARY

The established syndrome of an elongated styloid process, the syndrome which is typical, is reviewed. An atypical syndrome, referable to involvement of the external or the internal carotid artery, is presented for consideration. The symptoms, the diagnosis and the treatment of both syndromes are discussed. The intraoral surgical technic for shortening the elongated styloid process is described. Complications are reported as minimal, and the intraoral surgical approach is thought to be ideal for excellent and permanent results.

## LYMPHOID HYPERPLASIA OF THE EPIPHARYNX

A New Method for Control

S EUGENE DALTON, M D

VENTNOR CITY, N J

THE NEW FEATURE of this method is the added emphasis of thyroid dysfunction and infection of the paranasal sinuses as etiologic factors in the production of hyperplasia and hypertrophy of lymphoid tissue in the epipharynx. It follows that the correction of these pathologic conditions will help alleviate the abnormal growth of this tissue and the sequelae of such growth.

### ANATOMY

Functionally, the epipharynx is an annex to the respiratory portion of the nasal cavities. In contradistinction to the rest of the pharynx, it normally remains open at all times. It is bounded anteriorly by the choanae, the posterior wall is nearly vertical, extending upward to blend with the vault, and is bounded by the spinal column. The roof lies under the body of the sphenoid bone and extends to the superior margins of the orifices of the eustachian tube. The floor is the upper surface of the soft palate. Each side wall is formed by the orifice of the eustachian tube, the fossa of Rosenmüller and torus tubarius. The epipharyngeal space is lined by mucosa, which contains ciliated columnar epithelium and the lymphoid layer. Beneath this is the muscular layer except in the fornix. Here the mucosa is attached to the bone only by a thin hard connective layer. Between the mucomuscular layer and the prevertebral cervical fascia is the so-called retrovisceral space, which contains compound tubular mucoserous lymph glands. The middle gland is present during childhood, but the two lateral glands at the level of the atlas are not present until later in life. Three groups of epipharyngeal pouches may be noted in the photographs of this area. Four pouches with slitlike apertures are situated beneath the lower borders of the inferior turbinates. The

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The photographs in natural color accompanying this article were taken from the "Kodachrome" motion picture of the epipharynx presented before the American Academy of Ophthalmology and Otolaryngology, in Chicago, in October 1945, by S Eugene Dalton, M D



third group, triangular in shape, occupies the central part of the post-epipharyngeal wall. These pouches are vascular and harbor numerous bacteria, as revealed by cultures. Infections are readily absorbed from them into the blood and lymphatic vessels. The bony vault of the pharynx is the site of the pharyngeal tonsils. Here also is the site where hyperplasia of the lymphoid tissue occurs in many cases after the adenoid tissue has been removed.

The mucosa of the epipharynx is continuous with that of the eustachian tube. However, there are some structural changes of importance. The epithelium is of the ciliated columnar variety, while the tunica propria is divided into three well defined layers, namely, the basement membrane, a lymphoid and a glandular layer. The lymphoid layer varies in different parts of the tube, being very thin in bony portions and well developed at the pharyngeal end. Sometimes the lymphoid layer at this end is referred to as the tubal tonsil. It contains numerous ducts from glands in the glandular area and has a rich vascular supply of the lymphatic network.

The important relations of the lateral aspects of the cartilaginous portion of the eustachian tube are those with the tensor palati muscle and the mandibular division of the trigeminus nerve, the middle meningeal artery, the otic ganglion and the medial (internal) pterygoid muscle. Beneath the mucosa of the eustachian tube lies a most efficient lymphatic drainage system.

#### LYMPHOID HYPERPLASIA AND EFFECT OF IRRADIATION

Briefly the chief alterations noted on histologic examination of hypertrophied lymphoid tissue prior to irradiation are hyperplasia and chronic inflammation.

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*A*, four pouches with slitlike apertures that occur beneath each inferior turbinate.

*B*, third group of pouches, triangular in shape, located in the central part of the postepipharyngeal wall.

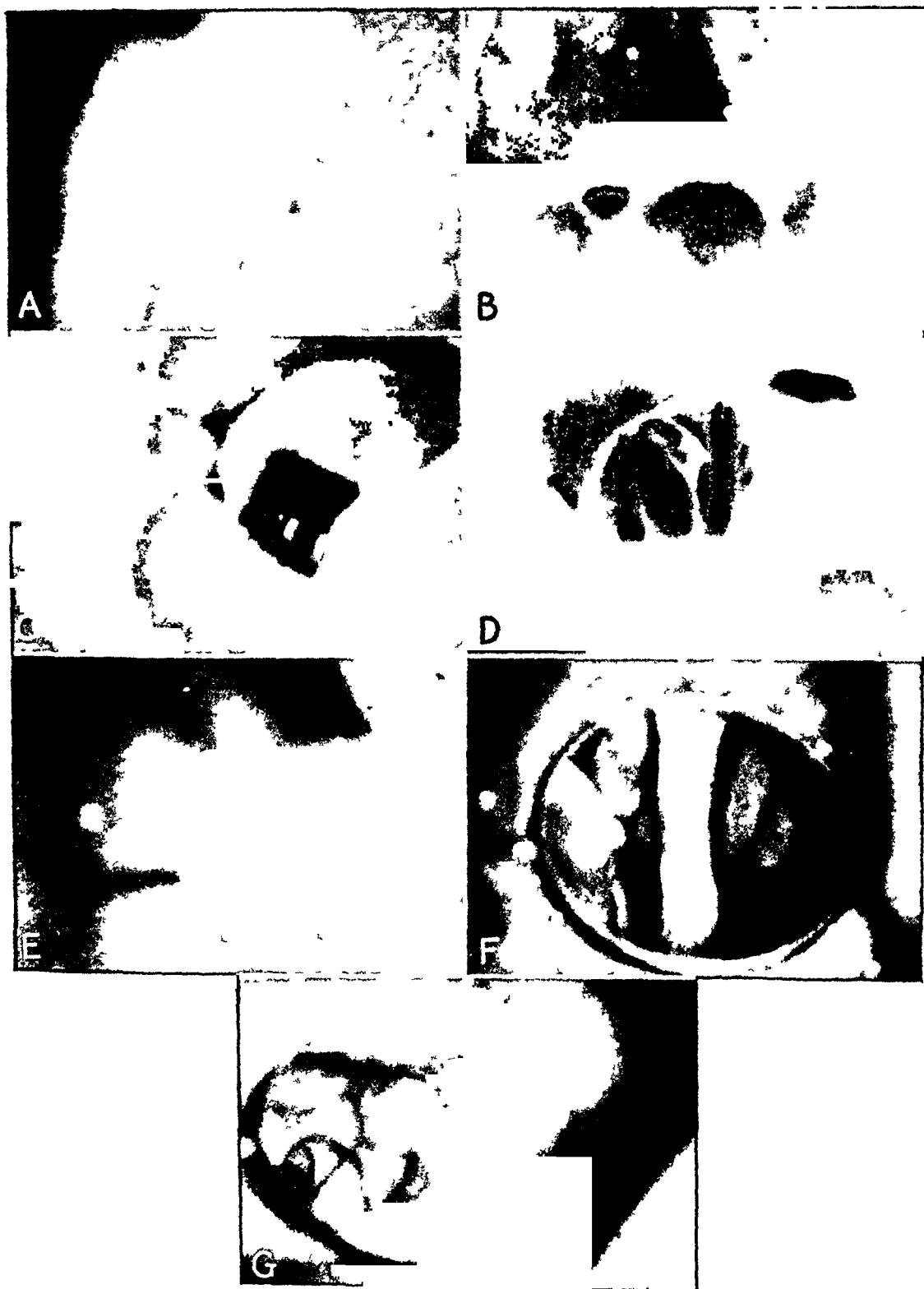
*C*, epipharynx that had been almost completely obstructed by hypertrophied and hyperplastic lymphoid tissue for the past fourteen years. The patient was a young woman suffering from suppurative sinusitis and hyperthyroidism. Her basal metabolic rate was plus 22.

*D*, epipharynx of same young woman eighteen months after treatment and operation. The basal metabolic rate was plus 4.

*E*, hypertrophied lymphoid tissue causing partial obstruction of the epipharynx of a man aged 21, who had suppurative sinusitis and hypothyroidism. His basal metabolic rate was minus 23. The tonsils and adenoids had been removed at 2, 8 and 15 years of age.

*F*, epipharynx of same patient three years after cure. The posterior border of the septum and the middle and inferior turbinates are shown by oral mirror photography.

*G*, in the torus tubarius, the orifice of the eustachian tube, a part of the inferior turbinate and the posterior border of the septum are shown.



(See legend on page 612)



The rapid proliferation of the cells of the nodules appears to be followed by an increase in the number of polyblasts. The amount of edema within the nodules varies but is most conspicuous in those removed from allergic patients. Dilatation of lymph channels occurs beyond the nodules while lymph channels within and around the nodules appear to be largely obstructed and frequently obliterated. Obliteration is caused by fibroblastic activity and proliferation of the endothelial cells. Although there is initial hyperplasia of the adjacent glandular structure atrophy ensues if chronic inflammatory activity is prolonged.

Lymphocytes are regarded as the most radiosensitive of the cells of the body. They show high radiosensitivity and a great ability to regenerate after small doses of radiation.<sup>1</sup> Similarly the lymph tissues throughout the body demonstrate high radiosensitivity and great powers of recovery after small doses. Suberythemal amounts of radiation cause degeneration of lymphocyte nuclei and breaking up of germinal centers within a few hours. The destruction of lymphocytes continues for days after such irradiation and is accompanied by considerable macrophage activity. Higher doses result in a more rapid and profound destruction of lymphocytes, with decrease in the size of nodes due to destruction of most of their contained cells. Repair takes place by collapse of the nodes with connective tissue replacement.<sup>12</sup> If the connective tissue is extensive the node becomes less resistant to infection.

The mechanism whereby abnormal lymphoid tissue produces profound changes in the middle and perhaps also in the internal ear remains obscure.

Aside from the obstructive features and the ability to harbor infection, attention must be paid to the role of the lymphoid tissue and the lymph channels of the eustachian tube which pass along this tube and end in the retropharyngeal lymph nodes.

#### CAUSES OF DEAFNESS

Mao and Hughson<sup>2</sup> ascribed the deafness of the 540 children in the Pennsylvania School for the Deaf to the following causes:

Biologic defects	53 per cent
Trauma	14 per cent
Meningitis	17 per cent
Contagious diseases (such as measles, scarlet fever, etc)	15 per cent
Incidental causes	1 per cent

1 Desjardins, A. U. Science **75** 569, 1932.

1a Warren, S. Effects of Radiation on Normal Tissues, Reprint No. 560, Harvard University Cancer Commission, 1942, pp. 12-13.

2 Mao, C. Y., and Hughson, W. Patency of the Eustachian Tube in Relation to Profound Hearing Loss in Childhood, Arch. Otolaryng. **33** 821-829 (May) 1941.

In regard to the group of 53 per cent whose deafness was ascribed to biologic defects it is felt that the biologic defect may render the individual child's auditory apparatus more susceptible to a variety of disturbances, such as infections of all kinds and degrees. In addition, mechanical factors and nutritional or endocrine imbalances may play a part. To all these the normal person of this age would probably be immune or at least would present a higher degree of resistance so far as the auditory mechanism is concerned. Mao and Hughson stated that in this group of profoundly deaf children neither patency nor obstruction of the eustachian tube is a factor of real importance.

There are, however, other groups of children and adults in whom lymphoid hyperplasia and hypertrophy obstructing the pharyngeal end of the eustachian tube or any portion of the tube will definitely affect the acuity of hearing.

#### HISTOLOGIC CHANGES DUE TO INFECTION

In chronically inflamed glands there is a tendency toward lymphoid infiltration. In the atrophy resulting from the physiologic decline of some organs, such as the ovary, the prostate gland, the breast and the thyroid gland, and in almost all tissues with atrophy due to chronic inflammation there is infiltration of hypertrophied lymphoid tissue. The function in all likelihood is to remove the debris incident to the slow disintegration, along with this process in any glandular organ there are apt to be focal areas of hypertrophy of mucous glands aimed at compensating for the loss of function of the destroyed glands. Infections play no small part in the pathologic changes.<sup>3</sup> According to J. R. Lindsay,<sup>4</sup> the major cause of deafness in early years is inflammatory disease of the eustachian tube and the middle ear.

These inflammatory diseases appear first as acute infections of the nasopharynx, the nose, the throat and the sinuses, the invading organisms attacking the mucosa and especially the lymphoid tissue.

The inflammatory process in this early stage may be arrested with proper care, provided the patient's vital forces will respond adequately in producing enough immunity or antibodies to counteract the infection. This vital force depends to a certain degree on the function of the thyroid gland. If the infection is not arrested in the early stage, other tissues are invaded, the lymphatic channels are occluded, adequate drainage is blocked, and suppuration occurs. Without relief, the process goes into the chronic state, producing chronic sinus infection and hypertrophy of lymphoid tissue with their sequelae.

<sup>3</sup> Konzelman, F., director of the laboratory of the Atlantic City Hospital, Atlantic City, N. J. Personal communication to the author.

<sup>4</sup> Lindsay, J. R. Eustachian Tube Function and Deafness, *Minnesota Med* 62:250-257 (March) 1943.

## APTITUDE TEST

An aptitude test was conducted for the students of the United States Coast Guard Radio School. Some of the findings have a direct bearing on this problem.

We used the audiometer test, clinical examination and a personal history as the basis of our investigation. The graduate students had an average decibel loss of 15.7 for air conduction and 1.1 for bone conduction, while the dementees had an average decibel loss of 19.1 for air conduction and 6.3 for bone conduction. Of the graduates, 12.9 per cent had had scarlet fever while 28.6 per cent of the dementees had had this disease, 19.7 per cent of the graduates, compared with 52.0 per cent of the dementees, had sinus infection, 9.0 per cent of the graduates, compared with 22.0 per cent of the dementees, had epipharyngeal lymphoid hypertrophy.

A mental fatigue test was given all students. The dementees' efficiency declined 50 per cent faster than that of the graduates. It was concluded that failures of students to complete the radio school course were due in part to mental fatigue caused by decreased acuity of hearing and by infection.

The aptitude test is superior to the psychologic, intelligence quotient test in rating students in this type of work. Racial characteristics are a definite influencing factor. Unfortunately, we were unable to make basal metabolic rate tests on these students.

## INFLUENCE OF THYROID GLAND AND INFECTION

The influence of thyroid gland activity on lymphoid tissue and infection of the upper respiratory tract is marked.

Hyperthyroidism, according to R. C. Moechlig,<sup>5</sup> is frequently associated with hypertrophy of the nasal mucous membranes, polyp formation and allergic states, such as hay fever, urticaria, eczema and asthma. Allergy is related to the thyroid gland through the sympathetic-hypophyseal system.

The relationship and influence of the thyroid gland on the pituitary gland is an all-important one, for by this relationship and influence we can understand that the thyroid gland would affect the mesodermal tissue via the pituitary changes. The lymphatic channels, the blood and blood vessels and the reticuloendothelial system are derivatives of the mesoderm.

A. Kocher<sup>5</sup> stated that lymphoid hypertrophy is in direct relation to hyperthyroidism and, according to Boyd, lymphoid tissue shows

<sup>5</sup> Kocher, cited by Moechlig, R. C. Hyperthyroidism, *Clinics* 1:1115-1167 (Feb.) 1943.

changes almost as constant in character as those of the thyroid gland itself Kochei also called attention to the relative lymphocytosis which is found frequently in the peripheral blood, monocytes predominating The cause of the lymphocytosis has been ascribed to the hyperplasia of the lymphatic system, the enlarged spleen and lymph glands, tonsils and Peyer's patches

The relationship of hypothyroidism to the lymphoid hyperplasia and infection is never more marked than in hyperactivity of the thyroid gland

Hypothyroidism occurring in young babies is most difficult to diagnose However, there are a few leading abnormalities that will help the physician marked overweight at birth and retardation in teething, walking and talking If these four signs are present at the same time the diagnosis is almost certain

In childhood the signs and the symptoms of hypothyroidism become more definite up to the age of 12 years The patients may have frequent colds and show a poor circulation, the skin is dry, and the hair develops poorly and becomes brittle The lymphadenoid tissue is quite prominent, as evidenced by enlarged tonsils and postpharyngeal adenoid tissue If this tissue is removed, in all likelihood it will repeatedly reform, and the younger the child the more apt is this tissue to recur, with more marked hyperplasia, unless scar tissue acts as a limiting factor

Basal metabolism is almost always found below normal but not as much below normal as in adult patients

The growth of the child appears to be retarded Roentgen examination of the various joints will reveal retarded development of the centers of ossification

Spontaneous adult hypothyroidism is ultimately a chronic disease, and the most important etiologic factors are acute and even chronic infectious diseases It is more common in women than in men (about 8 to 1) The predisposition of women to have spontaneous hypothyroidism is due to frequent congestion and toxic infectious disturbances of the thyroid gland during sexual life, such as menstruation, pregnancy and menopause<sup>6</sup>

The effect of infection on the thyroid gland is to alter its metabolism, which in turn reduces the patient's ability to resist further infection

The signs in a marked case are the swollen face, the thickened lips and nose and the swollen mucous membranes of the nasopharynx The sebaceous secretions are scant, and cutaneous eruptions of dif-

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<sup>6</sup> Crotti, A Diseases of the Thyroid, Parathyroids and Thymus, Philadelphia, Lea & Febiger, 1938

ferent kinds are often present. The nervous symptoms are striking. The memory is weakened, the mental processes are slow, and the organs of sense and of reflex are diminished. The voice is more or less husky owing to edema of the laryngeal mucous membrane. The organs of special sense are quite often affected, hearing, sight, taste and smell are diminished. Deafness to a greater or less degree is common and is due not only to infiltration of the mucous membranes but also to disturbances of central origin. Tinnitus is frequent. The temperature is lowered; it varies between 95 and 98.1. The pulse rate varies between 50 and 65, and the respirations are slow. The blood pressure is usually below normal.

In a review of the cases recorded in my office it was found that 19.2 per cent of the patients had thyroid dysfunctions. Lymphoid hyperplasia was present to a marked degree in 9.67 per cent, to a moderate degree in 32.88 per cent and to a slight degree or not at all in 57.35 per cent. Transillumination and roentgen study of the sinuses showed no evidence of infection in 72.2 per cent, moderate clouding in 20 per cent and marked clouding in 7.8 per cent. Many of the patients whose sinuses were not abnormal on such examinations were actually infected with streptococci, pneumococci or other toxin-producing organisms with a serous discharge. In some cases facultative anaerobic bacteria were found in the sinuses filled with a foul smelling gas. Females predominated 5 to 1 over males. Hyperactivity of the thyroid gland existed in a ratio of 3 to 1 over hyporeactivity. Pulse, temperature, respirations, weight and blood pressure are indicative of the basal metabolic rate, but they are by no means constant. The age is significant in that a slight abnormality of thyroid function produces more marked systemic effects in the child than in the older person. Also, the child responds more quickly and completely to treatment than the older person.

The basal metabolic rate does not always indicate the kind of treatment required to correct the condition. For example, all patients with minus rates do not respond favorably to thyroid therapy, nor do all with plus rates respond favorably to iodine therapy. They may require mixed treatment.

To avoid a mistaken diagnosis it is imperative that a stereotyped routine procedure be followed in examining all new patients. Some of the more frequently neglected procedures will be outlined. The history should include all infectious diseases the patient suffered from and their severity, together with any complicating sequelae, such as arthritis, rheumatism and cardiac and pulmonary dysfunctions. Gastrointestinal disorders and disease of the upper respiratory tract should be noted. Any nervous disturbances should be tabulated and studied.



The routine examination should include determination of temperature, pulse, respiration, blood pressure and reflexes. Sinus infections can almost always be diagnosed after a thorough examination of the nares, transillumination and roentgen study of the sinuses in a case in which there is a history of infection, pain and what is called frequent colds. Lymphoid hyperplasia can be seen in the epipharynx by means of the laryngeal mirror, the nasopharyngoscope, or the illuminating epipharyngoscope which I presented before the American Academy of Ophthalmology and Otolaryngology a few years ago. If any of the cardinal symptoms of thyroid dysfunction are present, a basal metabolic rate test should be performed, also studies of the blood and other tests necessary to determine the function of the thyroid gland.

Patients suffering from hyperplasia of epipharyngeal lymphoid tissue, suppurative sinusitis and dysfunction of the thyroid gland respond readily when the sinus infection is brought under control and the thyroid dysfunction is corrected. With some whose disease is of the more chronic protracted type, with definite hypertrophy of lymphoid tissue and formation of cicatricial tissue, it will be necessary to remove the tissue by surgical procedure, irradiation or diathermy, but not until after the previous treatment has been carried out.

In conclusion, the purpose of this paper is to point out the necessity of diagnosing and correcting thyroid dysfunction and suppurative sinusitis before removing hyperplastic lymphoid tissue by physical means. In the majority of cases the more radical means will be unnecessary.

## ACUTE NONSPECIFIC INFECTIONS OF THE PAROTID GLAND

A Review

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**D**URING the period of the past ten years it has become apparent that the incidence of acute nonspecific infections of the parotid gland has decreased to such a degree that this entity might now be considered within the realm of problems solved.

Mosher<sup>1</sup> has written of the unsolved problems of otolaryngology along with the disappearing diseases. Of the latter he mentioned epidemic sore throat, papilloma of the larynx, fibroma of the vault of the pharynx, tuberculosis of the larynx, and late effects of syphilis manifested by gumma of the soft palate and sinking of the external nose. Perhaps one can justifiably include the acute nonspecific infections of the parotid gland with the disappearing diseases mentioned at the time his article was presented to the Academy of Ophthalmology and Otolaryngology.

One readily recalls the ominous import of this type of disease prior to recent advances in treatment. With added knowledge of the treatment of infections of the parotid gland it has been possible to avoid the frequent end result of death and the incisional damage of skin, gland and facial nerve, save in unusually complicated cases.

The newer methods of diagnosis and treatment brought about by laboratory and biologic advances in all categories of medicine have made one mindful of additional progress in the future. In reading the Scriptures and historical writings one can appreciate the keen observations of men of Hippocrates' time in describing parasites, dropsy and the swollen gland, the parotid gland. It was he who initially described and recorded swelling of the parotid gland, but little did Hippocrates realize the subdivisions of that entity.

A review of acute nonspecific infections of the parotid gland from his time till now would be interesting in relation to the eras of new types of treatment.

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otolological Society, Inc.

1. Mosher, H. P. Unsolved Problems in Otolaryngology, *Tr Am Laryng, Rhin & Otol Soc* 43:27, 1937.

It is the purpose of this writing to review all acute nonspecific infections of the parotid gland of the past twenty years seen at St. Luke's Hospital, New York, through the department of otolaryngology. It is not my intention in the review to deal with the various possible causes, whether primary or secondary, but rather to interpret the decrease in the incidence of these infections. The major factors in the decrease are improved water and electrolytic balance, oral hygiene, chemotherapy and biotherapy. The use of penicillin in civilian hospitals was delayed by military necessities, and, too, the lack of patients treated with penicillin has made it impossible to evaluate this means of therapy. One patient was so treated, and the glandular involvement resolved in two weeks without incision. The last case of acute nonspecific infection of the parotid gland occurred late in 1943, hence the discussion of biotherapy will not be included.

Chronologically, the study and subsequent knowledge of water and electrolytic balance come first, inasmuch as they antedate modern hospital oral hygiene and the increased knowledge of the use of chemotherapy. Dehydration has played an important role in conditioning the gland and duct for invading organisms by reason of varying degrees of dryness of the mucous membrane and the inhibition of the peristalsis of Stensen's duct. The dry mucous membrane has been altered in its cellular metabolism and tissue reaction to the presence of microscopic organisms. The correction of depleted body fluids and salts has made it possible to bring about a decrease in the incidence of this type of infection. Water, both intracellular and extracellular, provides the necessary vehicle to make full use of the chemotherapeutic agent. Body fluids and sulfonamide compounds go hand in hand.

The injudicious use of intravenous and parenteral fluids did little good to the dehydrated body with concurrent infection. This subject of water and electrolytic balances will be discussed later in this review.

In recent years hospitals have employed full time dental residents to survey ward and some private patients for oral defects and to remove sources of infection, correct ill-fitting dentures and instruct the patient in the care of the mouth to keep it clean. Inflammatory changes about the opening of Stensen's duct must be prevented, in view of the likely complication of ascending infection. One of the cases reviewed was interesting and bears out this fact of oral hygiene. A note on the chart stated, "Pus from Stensen's duct stopped and the gland subsided following the removal of an ill-fitting upper denture."

Allergy as a cause was considered in this review. Only one case was diagnosed as allergic, though no smear for eosinophils was made. The gland subsided in one week. However, the patient was transferred to another hospital because of toxic encephalitis and arteriosclerotic heart disease. In the section headed "Comment" the subject of chronic

nonspecific recurring parotitis will be mentioned since the last mentioned case could possibly fall into this category at a later date.

Coughlin and Gish<sup>2</sup> grouped all acute nonspecific infections of the parotid gland as 'acute surgical parotitis'. The various descriptive pathologic terms as 'septic', 'gangrenous,' "suppurative," 'phlegmonous' or 'necrotic,' are only phases of the disease. In this review the terms "nonsuppurative" and "suppurative" are used only in regard to the chart showing the incidence of cases by years, since the need of incision of glands parallels the incidence of the acute infections of the parotid gland and suggests the virulence of the organisms active that year.

### THE ANATOMY

The complex anatomy of the parotid gland makes it difficult to treat these infections surgically without some injury being done to branches of the facial nerve. The facial nerve enters the gland after making its exit from the styloid foramen. It runs through the gland substance until it forms the plexus parotidicus and the distal branches that fan out to form the temporal, zygomatic, buccal, mandibular and cervical branch endings. This network of facial nerve twigs in close relationship with the gland proper makes it difficult to secure adequate drainage by incision without severing some of the nerve fibers with resultant motor loss to the area served by those fibers.

The gland is composed of the individual lobes, certain portions of the external carotid artery, the superficial part of the facial nerve, and their branches. The gland is covered by a very hard capsule that is continuous with the deep cervical fascia. Its weakest point is the medial superior surface in close contact with the buccal mucosa. This is a choice region for evacuation of a localized infection of the parotid gland by reason of it being possible to secure drainage without incision of the skin and possible damage of the nerve. Of course, the deep blood vessels must be avoided in this approach.

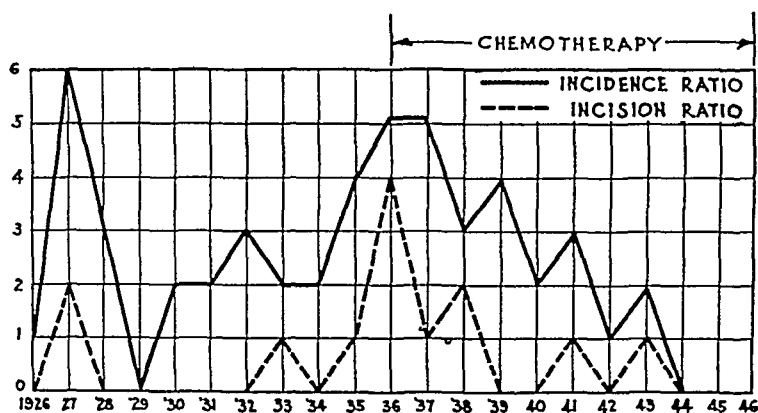
Stensen's duct is composed of a heavy fibrous coat and is lined with short columnar cell epithelium. Between these layers lie contractile fibers that give rise to peristaltic motions of the duct, which are innervated from the plexus sympathicus on the carotid artery, the facial nerve, the auriculotemporal nerve and the great auricular nerve. Gray stated that while the others are branches of the facial nerve, probably the branch from the auriculotemporal nerve is derived from the glossopharyngeal nerve via the otic ganglion. The duct crosses the masseter muscle and then is combined with its smaller ducts, pierces the buccinator muscle and emerges through the mucosa

<sup>2</sup> Coughlin, W. T., and Gish, L. R. Acute Surgical Parotitis, Arch Surg 45:361 (Sept.) 1912

of the oral cavity to form the opening of the ductus parotideus. It derives its blood supply from the external carotid artery and its local branches.

#### TWENTY YEAR REVIEW

This review is inclusive of all acute nonspecific infections of the parotid gland from January 1926 to October 1946. The patients admitted to all services during this period totaled 175,653. The number admitted monthly during this period was fairly consistent and never was more than 400, save the four individual years that did not influence the incidence/admission ratio materially. The number of acute nonspecific infections of the parotid gland totaled 50. As an interesting comparison, 32 specific infections of the parotid gland were recorded, these occurring accidentally after admission of the patients to the hospital, mostly on the pediatric service. The sex incidence was 26



The decreased incidence of acute infections of parotid glands

for males and 24 for females, and of these 5 were children. The glandular involvement was single in 39 cases and double in 11.

The bacteriologic study revealed the following organisms: non-hemolytic streptococci, *Staphylococcus aureus*, pneumococci, *Bacillus coli*, gram-positive cocci, gram-positive diplococci and one acute granuloma of syphilitic origin. The relative numbers of the different organisms are of no great value statistically.

Of the group, 4 infections were postoperative, 1 following iridectomy, 1 following operation for diverticula of the duodenum, and 2 resulting from cholecystectomy. This is mentioned only for interest, as all acute nonspecific infections of the parotid gland are considered as one group, the incidence, the treatment and the diagnosis not depending on previous surgical procedures. This method of considering infections of the parotid was suggested by Coughlin and Gish.<sup>2</sup>

In this group 7 were considered as unresolved by reason of the facts that death was due to pneumonia, arteriosclerotic heart disease, carcinoma of the colon with metastasis and carcinoma of the prostate with pulmonary metastasis, and 2 patients left the hospital early in the course of the acute glandular involvement. One of these patients gave a history of an acute glandular involvement one year prior to admission lasting about a month.

The chart shows the yearly incidence of acute nonspecific infections of the parotid gland. It is interesting to note that the need of incision is parallel to the rate of incidence. The reason for the apparent low incidence during the years prior to 1935 may be due to the gradual change over to the unit system in recording hospital and clinic patients. This system of cross filing has made for more comprehensive inclusion of all diagnoses. The decrease in incidence since 1935 has been gradual, and there have been no new cases of acute nonspecific infection of the parotid gland since late in 1943.

#### COMMENT

The decreased incidence of acute nonspecific infections of the parotid gland has been made possible by the increased knowledge of water and electrolytic balance, the correction of oral sources of infection and the unfolding use of chemotherapeutic agents. To a certain extent these improved methods of treatment have progressed in that order, and in the discussion they will be covered in that sequence.

In 1936, at the University of Michigan, Collier and Maddock<sup>3</sup> published the results of their work after an exhaustive study of water and electrolytic balance. From this study it was learned that water need is definitely related to body weight, i.e., 65 per cent of body weight is made up of water and any increase or decrease of that amount is evidence of disturbance of water balance. This may be determined by laboratory methods. In a general way, one may roughly estimate the intake-output balance in the normal man. However, in febrile or metabolic disease the need for an above normal intake of water necessitates a more thorough estimate of the water needs.

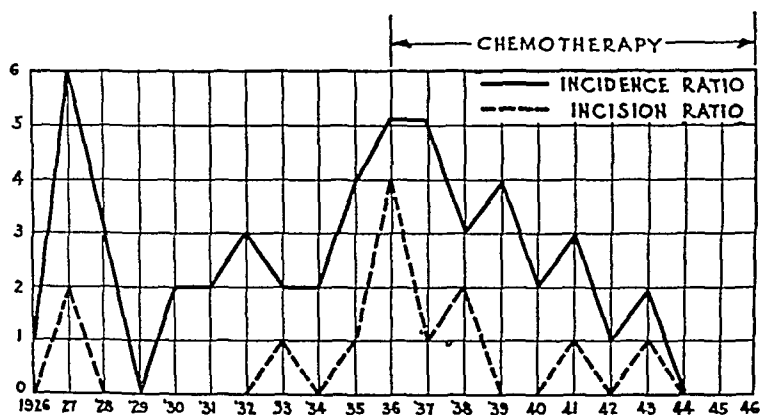
At a normal metabolic rate the output is about 250 cc from the kidneys, 200 cc from stools and 1,500 cc by vaporization, a total of 2,000 cc. With the output of 2,000 cc, the intake should equal or surpass that amount. The minimum intake for the kidney to carry on its function is 500 cc a day. A scanty output of high specific gravity is indicative of decreased water metabolism. The more normal the intake, the more likely that the kidneys can carry on their excretory

<sup>3</sup> Collier, F. A., and Maddock, W. G. Water and Electrolyte Balance. *Surg., Gynec. & Obst.* 70:340 (Feb.) 1940.

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Of the group, 4 infections were postoperative, 1 following iridectomy, 1 following operation for diverticula of the duodenum, and 2 resulting from cholecystectomy. This is mentioned only for interest, as all acute nonspecific infections of the parotid gland are considered as one group, the incidence, the treatment and the diagnosis not depending on previous surgical procedures. This method of considering infections of the parotid was suggested by Coughlin and Gish.<sup>2</sup>

In this group 7 were considered as unresolved by reason of the facts that death was due to pneumonia, arteriosclerotic heart disease, carcinoma of the colon with metastasis and carcinoma of the prostate with pulmonary metastasis, and 2 patients left the hospital early in the course of the acute glandular involvement. One of these patients gave a history of an acute glandular involvement one year prior to admission lasting about a month.

The chart shows the yearly incidence of acute nonspecific infections of the parotid gland. It is interesting to note that the need of incision is parallel to the rate of incidence. The reason for the apparent low incidence during the years prior to 1935 may be due to the gradual change over to the unit system in recording hospital and clinic patients. This system of cross filing has made for more comprehensive inclusion of all diagnoses. The decrease in incidence since 1935 has been gradual, and there have been no new cases of acute nonspecific infection of the parotid gland since late in 1943.

#### COMMENT

The decreased incidence of acute nonspecific infections of the parotid gland has been made possible by the increased knowledge of water and electrolytic balance, the correction of oral sources of infection and the unfolding use of chemotherapeutic agents. To a certain extent these improved methods of treatment have progressed in that order, and in the discussion they will be covered in that sequence.

In 1936, at the University of Michigan, Coller and Maddock<sup>3</sup> published the results of their work after an exhaustive study of water and electrolytic balance. From that study it was learned that water need is definitely related to body weight, i.e., 65 per cent of body weight is made up of water, and any increase or decrease of that amount is evidence of disturbance of water balance. This may be determined by laboratory methods. In a general way, one may roughly estimate the intake-output balance in the normal man. However, in febrile or metabolic disease the need for an above normal intake of water necessitates a more thorough estimate of the water needs.

At a normal metabolic rate the output is about 250 cc from the kidneys, 200 cc from stools and 1,500 cc by vaporization, a total of 2,000 cc. With the output of 2,000 cc, the intake should equal or surpass that amount. The minimum intake for the kidney to carry on its function is 500 cc a day. A scanty output of high specific gravity is indicative of decreased water metabolism. The more normal the intake, the more likely that the kidneys can carry on their excretory

<sup>3</sup> Coller, F. A., and Maddock, W. G. Water and Electrolyte Balance, *Surg., Gynec & Obst.* **70** 340 (Feb.) 1940.



processes This is important when chemotherapy is being used, for the kidneys must be enabled properly to excrete the sulfonamide crystals The feeble patient or the one with hyperthyroidism uses about 3,000 cc of fluid a day Operative procedures on a hot day will cause the patient to lose at least 3,000 cc of water on that day

The principal intake of water is that ingested plus the water derived from oxidation products This intake goes into three compartments, the blood, the intracellular and the extracellular space

Besides the establishment of normal water balance, the electrolytic balance must also be corrected if there should be a diminution of the blood chlorides from the normal of 570 to 620 mg per hundred cubic centimeters The determination of the acid-base equilibrium by means of carbon dioxide—combining power is important, to estimate the need of supplementing the chlorides in order to avoid acidosis The daily estimate of the sodium chloride utilized in metabolism is 11 grains (0.7 Gm) a day Experimentally it has shown that early shock may be obtained by infusion of more than this amount

When there has been loss of body proteins in the forms of albumin and globulin, it is necessary to make studies of blood plasma to rule on the possibility of hyperproteinemia or hypoproteinemia The function of blood plasma protein is to maintain normal osmotic pressure in the capillaries Normally the osmotic pressure of the blood plasma is such that the fluids tend to leave the tissues and enter the blood, but this is counteracted by the capillary blood pressure A decrease in blood plasma will mean less tissue fluids entering the blood stream and consequent storing of fluids in the tissues, causing edema

In recent years the full time dental residents added to hospital staffs have done much to abolish sources of infection, to correct ill fitting dentures and to educate the patient to maintain oral hygiene religiously Mucous membranes of the mouth which have altered cellular metabolism because of dryness are prone to become infected by organisms present in the mouth

Chemotherapy has been of considerable value in the treatment of acute nonspecific infections of the parotid gland Before this new means of therapy, treatment of a conservative type consisted of external hot and cold applications, massage of the gland, dilation and suction of Stensen's duct, injecting of antiseptic solutions into the duct and the use of chewing gum to excite secretion of fluids in the gland However, in acute inflammatory conditions chemotherapy brought about a more rapid subsidence of the glandular infections, which in turn obviated the need for incision of the gland The administering of sulfonamide compounds to a patient with normal water and electrolytic balance at the first sign of parotid swelling has not

only decreased the degree of inflammation but shortened the duration of the pathologic involvement. The early use of chemotherapy decreases the likelihood of pus formation.

In this review it has been shown that these cases were instances of acute nonspecific infections of the parotid gland. However, there is no guarantee that in the future some of them may not become instances of chronic recurring nonspecific parotitis. McCaskey<sup>4</sup> has mentioned this type of entity with the possible causes, i.e., lodging of foreign bodies in the duct, hyperplasia of the gland tissue occurring with diseases of the genital tract and of some of the endocrine glands, salivary retention in newborn infants, malaria, drug intoxication, specific infections such as tuberculosis, actinomycosis and syphilis, and allergy. These are possibilities, though in his conclusion he arrived at no definite opinion as to an etiologic factor. Biopsy demonstrated the chronic recurrence of pathologic involvement of the parotid gland. Fowlkes, discussing the paper of McCaskey,<sup>4</sup> made note of the frequency with which mental instability and mild psychosis were found in patients with chronic recurring nonspecific infections of the parotid gland seen by him at Bellevue Hospital. Earlier in this paper mention was made of a patient who had an acute infection of this gland that subsided but who was transferred to another hospital because of toxic encephalitis. It may well be that the glandular infection of this patient will eventually be found in the category of the latter type of nonspecific infections of the parotid gland.

#### CONCLUSIONS

1 There has been a decrease in the incidence of acute nonspecific infections of the parotid gland.

2 Improved use of water and electrolytic agents has corrected varying degrees of dehydration in patients with such infections.

3 Proper oral hygiene, the correction of ill-fitting dentures and the removal of sources of infection have protected the parotid duct from being invaded by organisms.

4 Chemotherapy and the improved water balance provided with it have greatly decreased the degree of pathologic involvement of the gland and shortened the duration of the infection.

<sup>4</sup> McCaskey, C. H. Chronic Non Specific Recurring Parotitis, *Tr. Am. Laryng., Rhin. & Otol. Soc.* 48: 56, 1942.

# BARRIER MEMBRANE OF THE COCHLEAR AQUEDUCT

Histologic Studies on the Patency of the Cochlear Aqueduct

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IT IS generally assumed that the cochlear aqueduct is a canal through which spinal fluid flows from the subarachnoid spaces to the scala tympani of the cochlea. This theory of the physiology of the cochlear aqueduct is based entirely on histopathologic observations. Grunberg, Voss, Ulrich, Grove, Crowe, and Perlman and Lindsay<sup>1</sup>, among others, collected a number of temporal bones of patients who succumbed soon after an intracranial operation or a fracture of the skull. When blood was found in the subarachnoid spaces of these specimens, blood was also noted in the perilymphatic spaces of the cochlea. In addition, red blood cells were demonstrated in the cochlear aqueduct, especially near its cochlear opening. From these observations Crowe deduced that "there is a normal flow of cerebrospinal fluid in the cochlear aqueduct from the meninges to the scala tympani."

Experiments done on animals and cadavers up to the present time have led to much confusion about the patency of the cochlear aqueduct, due to the numerous artefacts invariably present in these studies.<sup>2</sup>

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1 (a) Grunberg, K. Zur Frage der Existenz eines offenen Ductus perilymphaticus, *Ztschr. f. Hals, Nasen u. Ohrenh.* **2** 146, 1922. (b) Voss, O. Klinische und pathologisch-anatomische Folgeerscheinungen geburstraumatischer Schädigungen des Felsenbeins, *Monatschr. f. Kinderh.* **34** 568, 1926. (c) Ulrich, K. Verletzungen des Gehörorgans bei Schädelbasisfrakturen, *Acta oto-laryng.*, 1926, supp. 6, p. 1. (d) Grove, W. E. Otolologic Observations in Trauma of the Head. *Arch. Otolaryng.* **8** 249 (Sept.) 1928. (e) Crowe, S. J. Pathologic Changes in Meningitis of the Internal Ear, *ibid.* **11** 537 (May) 1930. (f) Perlman, H. B., and Lindsay, J. R. Relation of the Internal Ear Spaces to the Meninges, *ibid.* **29** 12 (Jan.) 1939.

2 Weber, Liel. Experimenteller Nachweis einer freien Communication der endolymphatischen und perilymphatischen Räume des menschlichen Ohrlabyrinthes mit extralabyrinthischen intracranialen Räumen, *Virchows Arch. f. path. Anat.* **77** 207, 1879. Retzius, M. G. Das Gehörorgan der Wirbelthiere, Stockholm,

During systematic studies of human and animal temporal bones, especially those with subarachnoid hemorrhages, I made observations which seem to contradict the foregoing conclusions as to the patency of the cochlear aqueduct

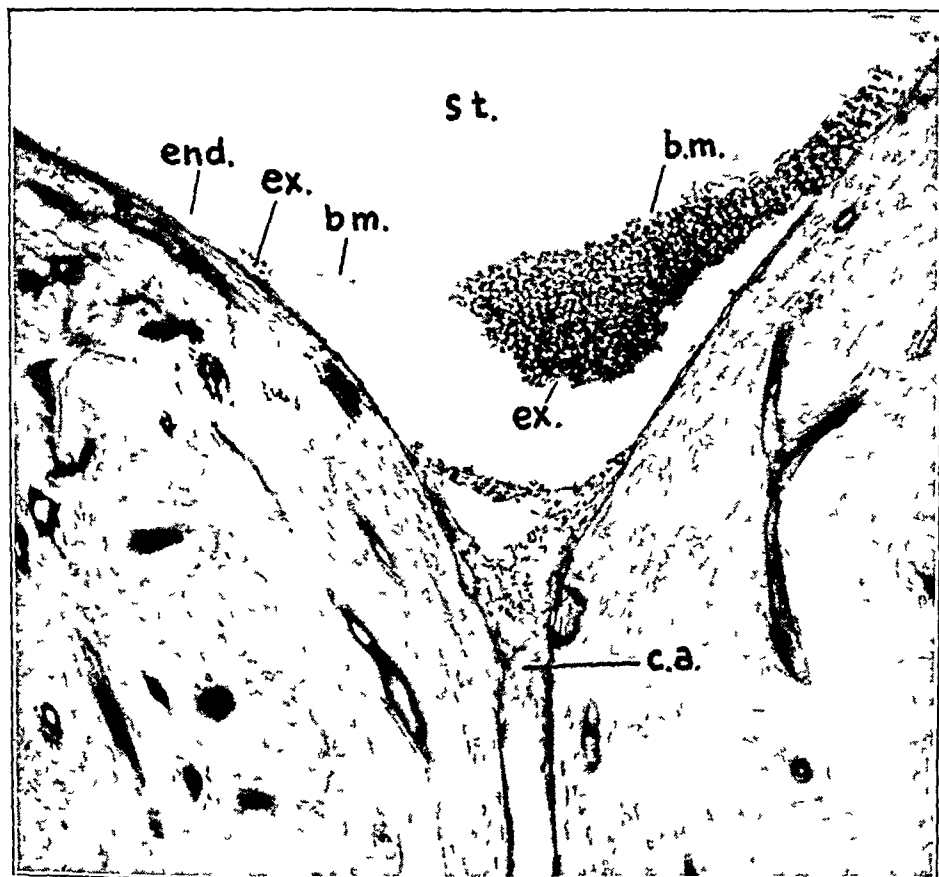


Fig 1 (case 1) —The patient died of suppurative leptomeningitis. Exudate (*ex*) penetrates through the cochlear aqueduct (*ca*) and pushes the thin barrier membrane (*b m*) into the lumen of the scala tympani of the cochlea (*st*). Note the infiltrating pus cells under the neighboring endosteum (*end*)

#### OBSERVATIONS

CASE 1—A 53 year old man died of fulminating suppurative leptomeningitis which apparently followed an ordinary cold. The spinal fluid pressure was 400 mm of water a few hours before death. Autopsy was performed one and a half hours post mortem.

Vertical serial sections showed the cochlear aqueduct to be filled with purulent exudate up to its cochlear opening. No exudate, however, was found in the peri-

Samson & Wallin, 1884. Siebenmann, F. Die Korrosionsanatomie des knochernen Labyrinthes des menschlichen Ohres, Wiesbaden, J. F. Bergman, 1890. Karlefors J. Der Aquaeductus cochleae beim Menschen, Acta oto laryng, 1924, supp 4, p 145. Meurman, Y. Zur Anatomie und Physiologie des Aquaeductus cochleae, Acta Soc med fenn duodecim, s B 13 175, 1931.

lymphatic spaces of the cochlea. All the exudate was accumulated under a thin membrane measuring less than 1 micron in thickness. This membrane seemed to separate the cochlear opening of the aqueduct from the lumen of the scala tympani. The exudate pushed the membrane toward the lumen of the scala tympani and also infiltrated between the neighboring endosteum of the scala tympani and the endosteal bone (fig 1).

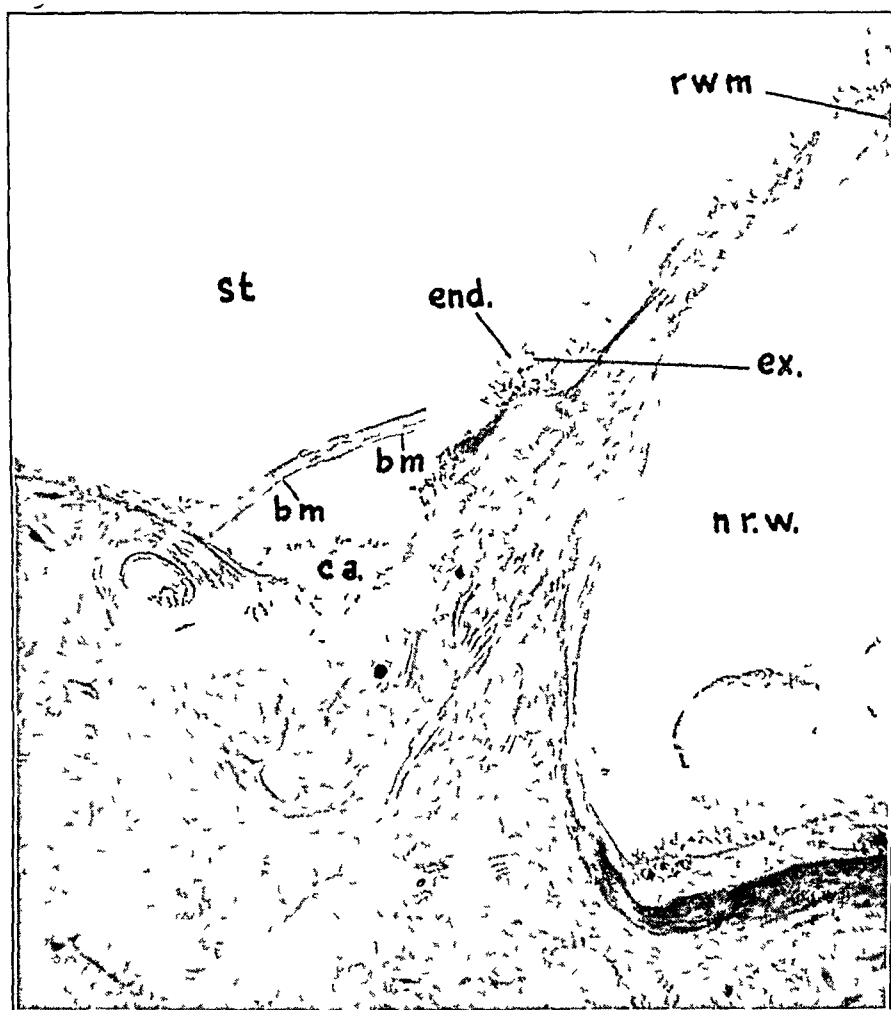


Fig 2 (case 2) —The patient died of purulent leptomeningitis and subarachnoid hemorrhage. Exudate (*ex.*) passing through the cochlear aqueduct (*ca.*) is accumulated under the barrier membrane (*bm*) and between the endosteum (*end.*) and the bony wall of the scala tympani (*st*). *rwm* denotes the round window membrane, *n.r.w.*, the niche of the round window.

CASE 2 —A 62 year old woman died of purulent leptomeningitis following acute *Pneumococcus* type III infection of the middle ear. The spinal fluid pressure was 600 mm of water a few hours before death. Autopsy, performed four hours after death, revealed subarachnoid hemorrhage in addition to purulent leptomeningitis.

Horizontal serial sections of the right temporal bone showed purulent exudate and blood in the cochlear aqueduct, extending to its cochlear opening where the

exudate and the blood were stopped by a membrane separating the aqueduct from the basal turn of the scala tympani. Blood and exudate could be traced from the aqueduct to the midportion of the round window membrane, at which place they were located between the swollen endosteum and the lamina propria of the round window membrane. From this area the exudate extended along the under surface of the basilar membrane, in which location a distinct endosteum was not recognizable (fig 2)

CASE 3—A 48 year old woman was admitted to the Presbyterian Hospital in coma and died shortly after admission. Autopsy, performed seven hours post mortem, revealed a cyst of the third ventricle of the brain

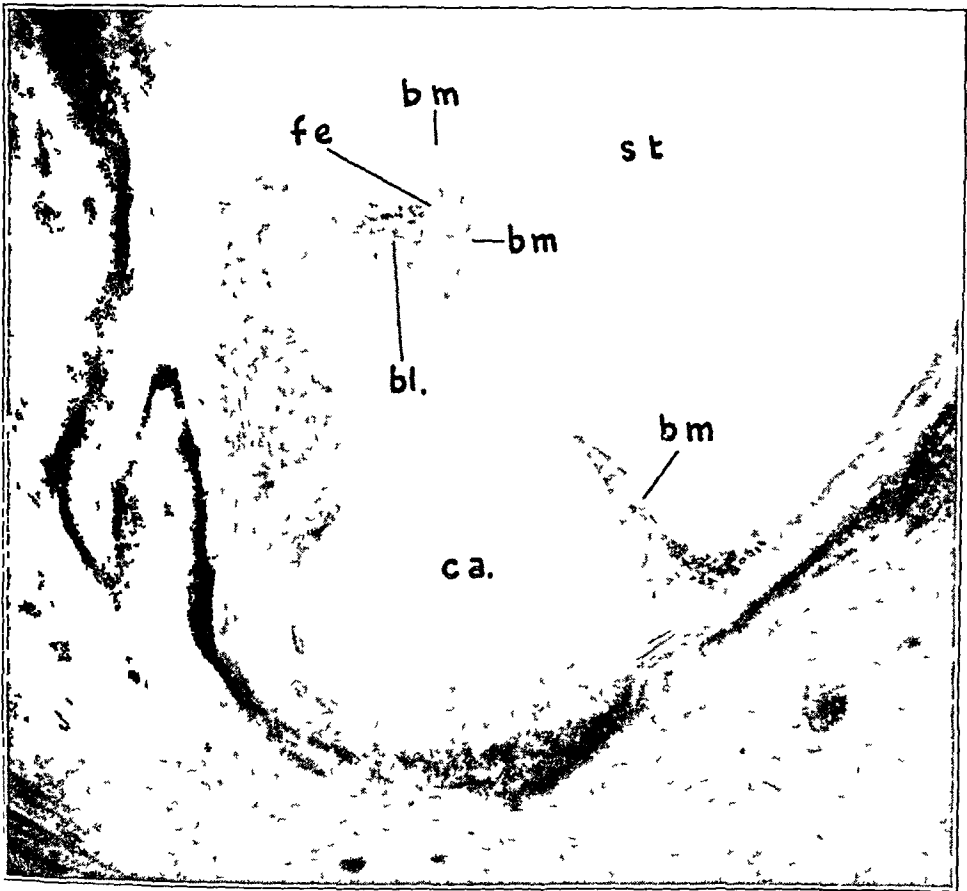


Fig 3 (case 3) —A barrier membrane (*bm*) separates the opening of the cochlear aqueduct (*ca*) from the scala tympani of the cochlea (*st*) in a 48 year old woman. Blood (*bl*) has accumulated under the ruptured and folded end (*fe*) of the barrier membrane.

In horizontal serial sections of the left temporal bone, blood was found in the wide, inferior portion of the cochlear aqueduct. A pool of blood was seen under a separating membrane at the cochlear opening of the aqueduct. No blood was found in the scala tympani. The membrane was ruptured at one end near its continuation into the endosteum and was folded on itself. Most of the blood cells accumulated right under the ruptured part of the separating membrane. Measurements of the floating folded portion of the membrane indicated that, if straightened out to its apparent former position, it would just reach the point of its previous attachment to the endosteum of the bony wall of the scala tympani (fig 3)

Two temporal bones obtained in cases 4 and 5 are representative specimens in our collection showing the presence of a continuous membrane which separates the cochlear aqueduct from the scala tympani

CASE 4—A young man, 22 years old, died of obstruction of the small intestine Autopsy was performed four and a half hours post mortem

In horizontal serial sections a membrane was seen overbridging the cochlear opening of the cochlear aqueduct and separating it from the lumen of the scala

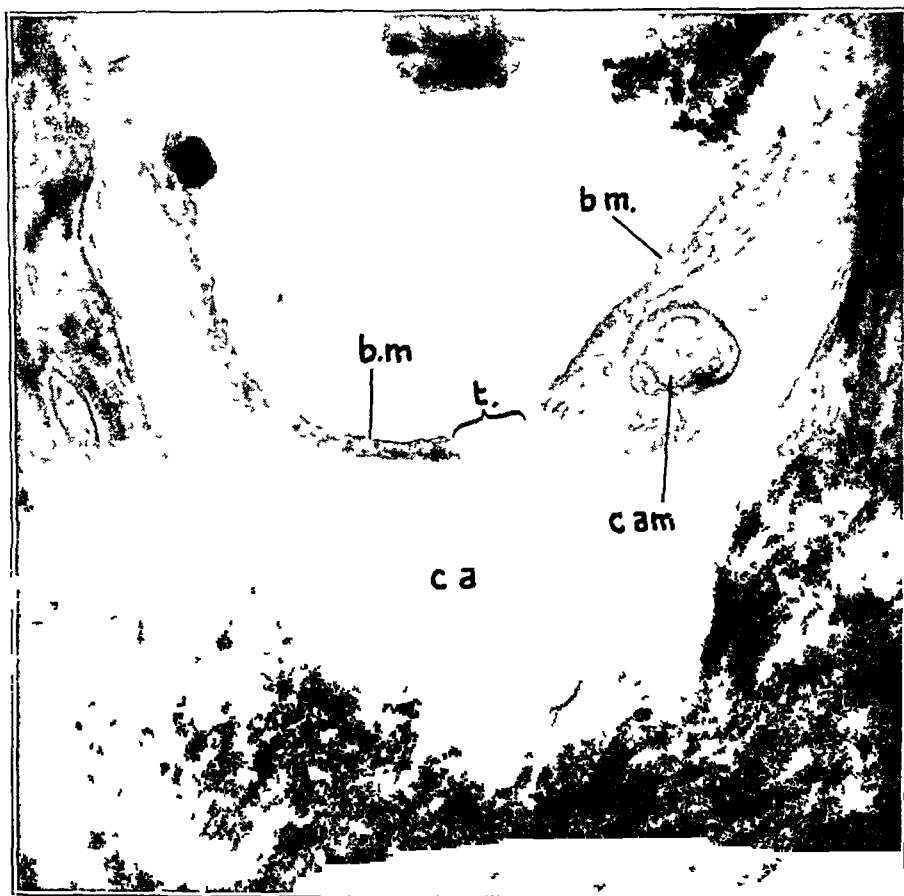


Fig 4 (case 4) —The cochlear opening of the aqueduct (*ca*) contains a barrier membrane (*b.m.*), under which a fully developed corpus amylaceum (*cam*) is visible There is a small tear in the the middle of of the membrane (*t*)

tympani This membrane was directly continuous with the endosteum covering the bony walls of the scala tympani The region of the cochlear opening of the aqueduct was studied in all consecutive serial sections (fig 4)

CASE 5—A woman 57 years old died of carcinoma of the liver Autopsy was performed one hour post mortem

Vertical serial sections of the right temporal bone showed a very thin membrane separating the cochlear aqueduct from the perilymphatic spaces of the cochlea This membrane consisted of one to two parallel layers of cells containing elongated, flat nuclei The membrane was found to be ruptured near its attach-

ment to the bony wall at one side but both ends were directly continuous with the endosteum of the scala tympani (fig 5)

CASE 6—A 56 year old woman gave a history of Paget's disease of the skull. She also gave a history of deafness of five years' duration, the loss of hearing becoming more acute during the last month of her life. She died of lobar pneumonia and edema of the lung.

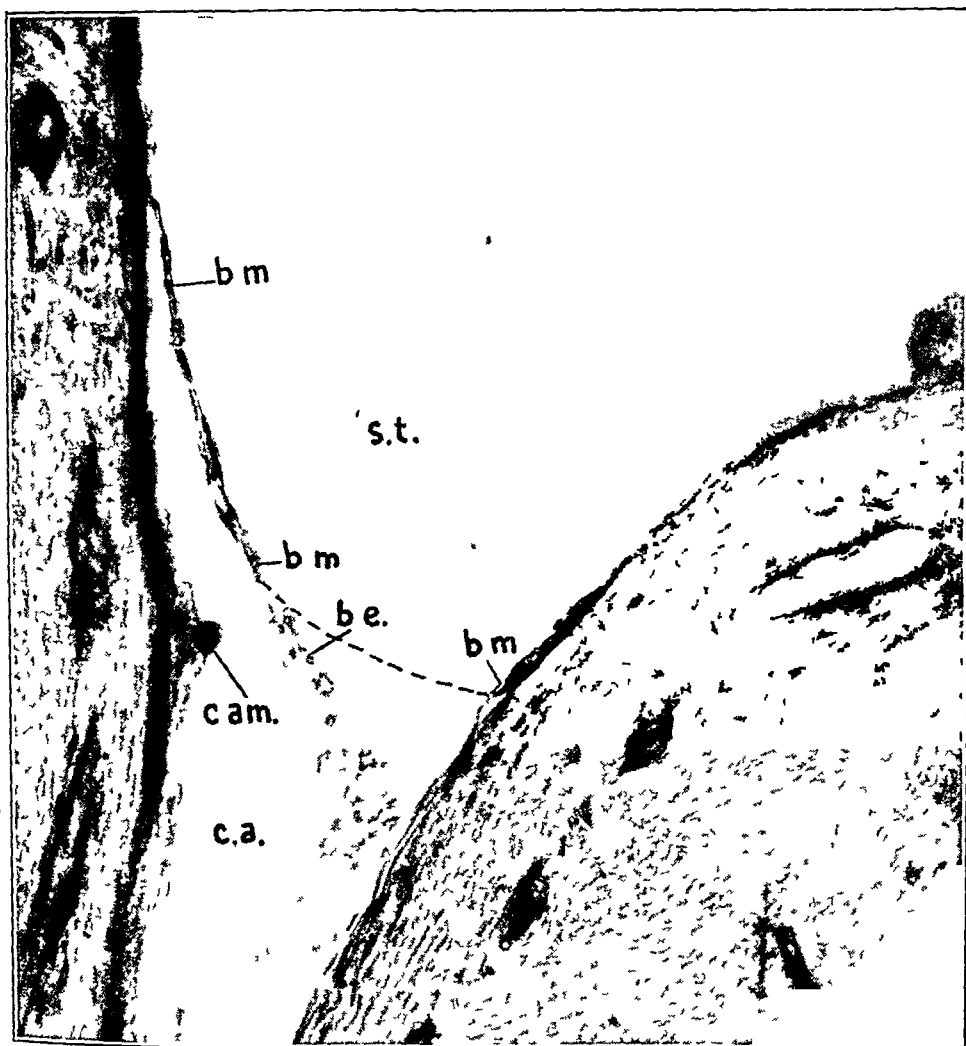
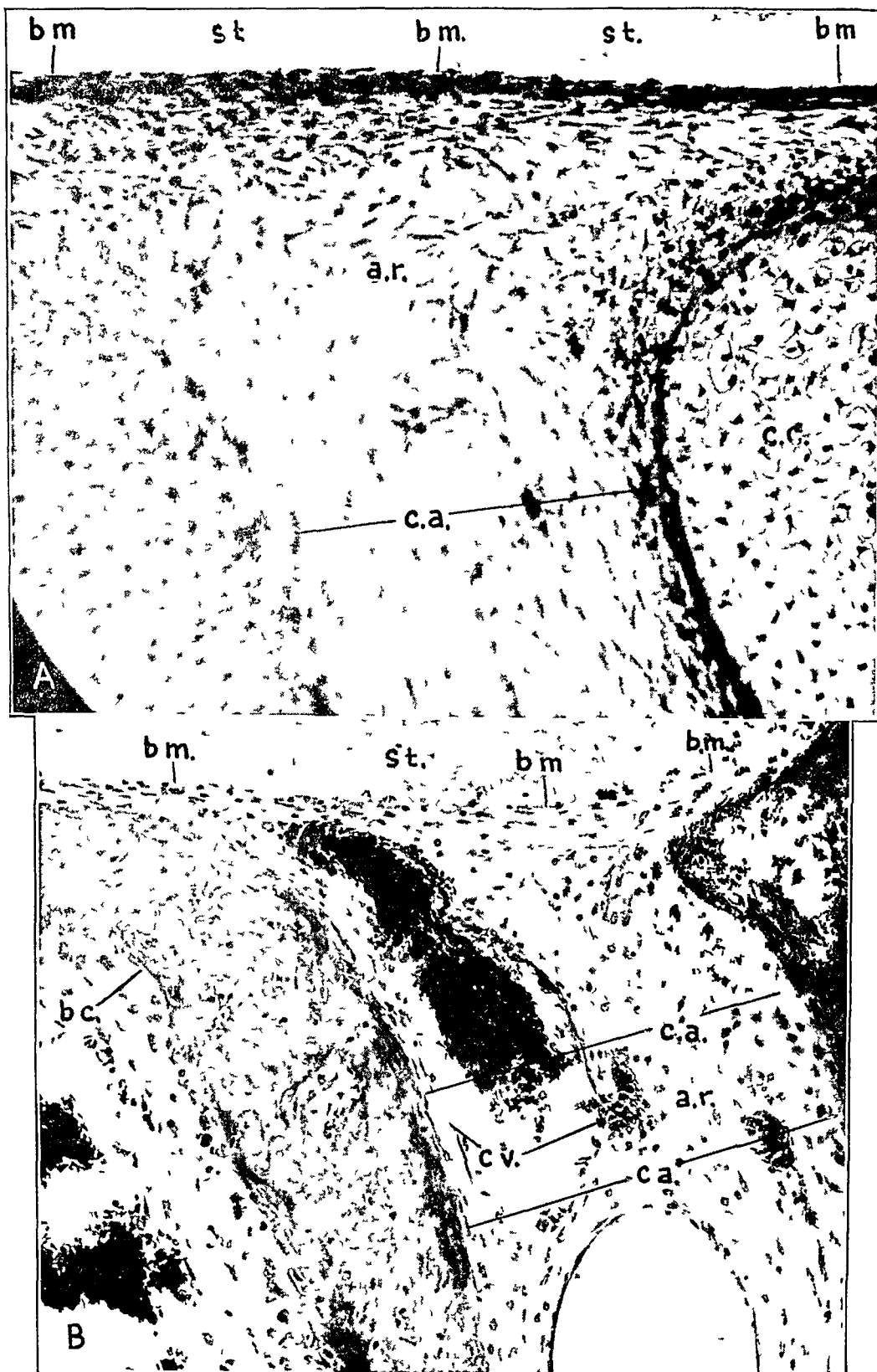


Fig 5 (case 5) —A barrier membrane (*bm*) separates the opening of the cochlear aqueduct (*ca*) from the lumen of the scala tympani of the cochlea (*st*). On one end the membrane is detached from the bony wall. The letters *be* denote the broken end of the membrane, *cam*, a corpus amylaceum. The dotted line shows the original position of the membrane.

Histologic examination of the left temporal bone in horizontal serial sections showed that newly formed Paget's bone had invaded and completely obliterated the cochlear aqueduct for a distance of 0.6 mm, starting 1.6 mm from its cochlear opening into the scala tympani. Immediately below this level the bony wall of the aqueduct was found to be partially destroyed and its lumen greatly narrowed by invading bone and granulation tissue. From the 1.6 mm level up to its cochlear opening the aqueduct was normal and contained typical arachnoidal reticulum.





Figures 6A and B  
(See legend on opposite page)

Considerable hemorrhage was visible in the cuplike opening of the aqueduct into the scala tympani. In the cochlear duct of the basal turn there was a small hemorrhage lining the lateral wall, starting at the stria vascularis. No blood was found in the cochlear aqueduct in any of the sections below the level of complete obliteration, although both the dura perosteum and the arachnoid reticulum were well preserved.

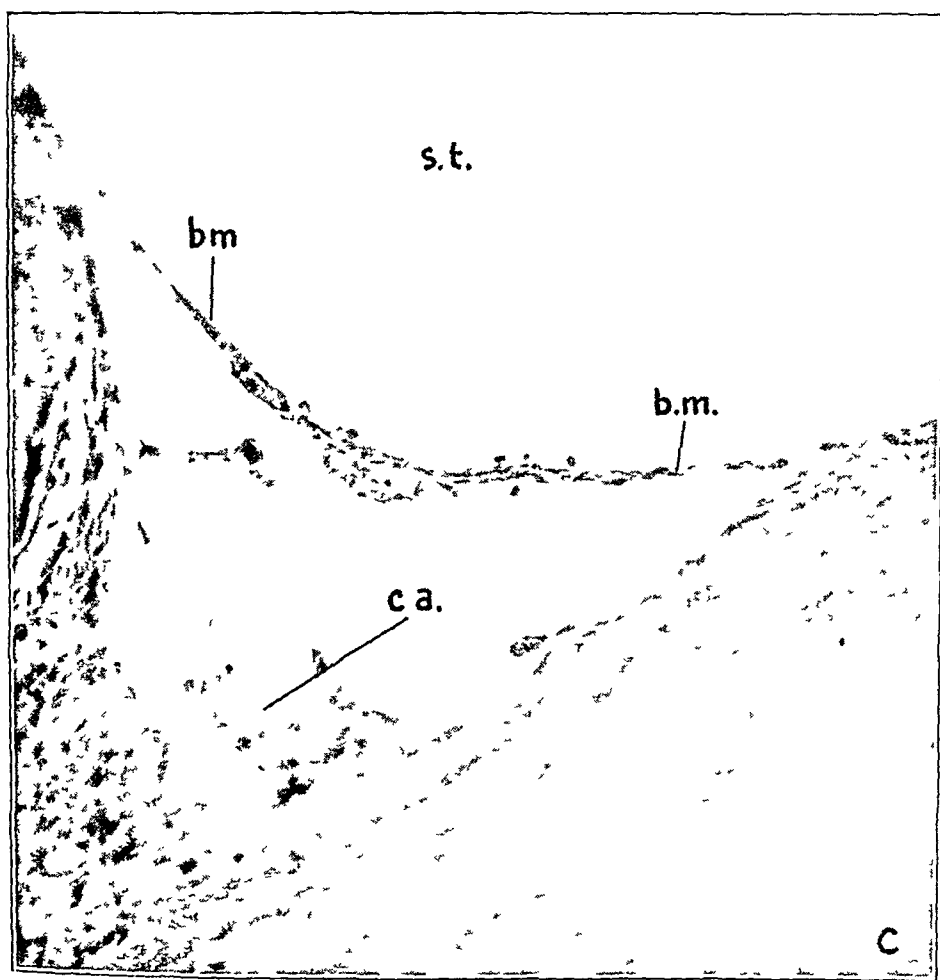


Fig 6—A shows a barrier membrane (*bm*) separating the cochlear aqueduct (*ca*) from the scala tympani of the cochlea (*st*) in a 110 mm (crown rump) human fetus. The membrane is made of two to three parallel layers of elongated cells. The letters *cc* designate the cartilaginous capsule of the cochlea, *ar*, the arachnoid reticulum of the cochlear aqueduct.

B shows the cochlear aqueduct (*ca*) of a 180 mm (crown rump) human fetus, at the cochlear aperture of which a separating membrane (*bm*) is visible. Note the parallel orientation of the cells of the membrane. The letters *st* designate the scala tympani of the cochlea, *bc*, the bony capsule of the labyrinth, *cv* the cochlear vein, *ar*, the arachnoid reticulum of the aqueduct.

C shows a membrane (*bm*) separating the aperture of the cochlear aqueduct (*ca*) from the scala tympani of the cochlea (*st*) in a 200 mm (crown rump) human fetus. The membrane consists of one to two layers of cells containing fusiform nuclei.

The bulb of the jugular vein was unusually large, measuring 8 by 8 mm in some sections, and extended upward to the level of the posterior semicircular canal. It occupied so much space in the petrous bone that its wall came in direct contact with the middle portion of the cochlear aqueduct.

Examination of the right temporal bone revealed that newly formed bone replaced a large section of the cochlear aqueduct, completely obliterating the narrow portion. A moderate number of red blood cells were seen in the wide, inferior portion below the level of the obliteration. There was no blood in the cochlea.

No pathologic displacement of the round window membrane was noticed on either side.

#### COMMENT

A continuous membrane separating the cochlear opening of the aqueduct from the scala tympani of the first turn is clearly visible in the 110 mm (crown-rump) human fetus (fig 6A). At this stage the membrane consists of two to three layers of arachnoidal type cells, the nuclei of which are ovoid shaped and are arranged horizontally in dense parallel layers. This well organized membrane shows a sharp contrast with the underlying loosely scattered reticulum cells of the aqueduct. On one end the separating membrane goes directly over the wall of the scala tympani on the other end, into the inner layer of the round window membrane. A similar membrane is equally evident in the 130, the 180 (fig 6B), the 200 (fig 6C) and the 300 mm (crown-rump) human fetus.

A similar continuous separating membrane can often be demonstrated (figs 1 to 5) in adult temporal bones, although no description and demonstration of this structure or of its development can be found in the literature. The name "barrier membrane of the cochlear aqueduct" (*membrana limitans aperturæ internæ aqueductus cochleæ*) is proposed for this structure. The endosteum covering the wall of the scala tympani at the edge of the inner aperture of the cochlear aqueduct measures 1 micron or less in thickness and consists of a single layer of cells containing very flat nuclei. The barrier membrane of the cochlear aqueduct is a direct continuation of the neighboring endosteum (figs 1 to 5). In some instances the reticulum of the aqueduct is in contact with the barrier membrane, which can be recognized only by the parallel orientation of its cell nuclei. In other temporal bones the barrier membrane is clearly separated from the underlying reticulum by an empty space. In early childhood the membrane in general seems to be thicker than in adult life.

In many cases all consecutive sections of the region have to be studied in order to demonstrate this membrane. Early postmortem fixation and good decalcification of the temporal bone are important factors. Tearing of Reissner's membrane is frequent during histologic preparation. It is not surprising that tearing of the barrier membrane is even more frequent, because it is thinner and covers a much smaller

area In rabbits a continuous membrane separating the opening of the cochlear aqueduct from the scala tympani is a standard histologic feature Immediate postmortem fixation and easier decalcification of rabbit temporal bones probably account for this fact The extent to which the described membrane closes the opening of the cochlear aqueduct to fluids can be made certain by reconstruction studies only From the evidence gained from observations in cases 1 to 6 it seems quite probable that the separating membrane forms a complete barrier between spinal fluid and perilymph and prevents the spinal fluid from flowing into the cochlea under physiologic circumstances

Rapid increase of the pressure in the subarachnoid spaces may result in pathologic fissures in the dense reticulum of the cochlear aqueduct and in rupture of the barrier membrane at the cochlear opening of the aqueduct The role of the dense reticulum located near the barrier membrane and of the corpora amylacea of the aqueduct seems to be to slow down the flow of spinal fluid in order to protect the delicate barrier membrane against sudden increase of pressure Bagley's<sup>3</sup> studies on dogs showed that sterile meningitis developed after blood had been injected into the cisterna magna Similarly a highly increased pressure of spinal fluid will follow subarachnoid hemorrhages which were originated by cranial trauma or neurosurgical operation Rapidly increasing pressure of the spinal fluid may rupture the barrier membrane of the aqueduct, which can yield to pressure only to a limited degree, because of its shortness Thus, a pathologic communication may be opened between spinal fluid and perilymph, and blood may be carried by the spinal fluid into the scala tympani

The foregoing explanation is supported by certain histopathologic developments which are occasionally observed in temporal bones following subarachnoid hemorrhages or purulent meningitis In these instances, the barrier membrane which separates the lumen of the cochlear aqueduct from the perilymphatic spaces of the cochlea is lifted away from the opening of the aqueduct, and sometimes the neighboring endosteum of the scala tympani shows similar displacement The blood or the exudate, after having passed through the cochlear aqueduct, is accumulated under the separating membrane Cases, 1, 2 and 3 demonstrate the pathologic displacement of the barrier membrane following rapid increase of spinal fluid pressure, which was 400 mm in case 1 and 600 mm in case 2

If the pressure of spinal fluid is not high enough to rupture the barrier membrane of the cochlear aqueduct, blood cannot enter the cochlea by this route This explains the observations made by Perl

<sup>3</sup> Bagley, C The Grouping and Treatment of Acute Cerebral Traumas, Arch Surg 18 1078 (April) 1929

man and Lindsay,<sup>14</sup> who found unimpaired hearing in a number of patients who had undergone craniotomy

Four facts support the intravital origin of the pathologic displacement of the barrier membrane and the endosteum. 1 Blood and exudate were found under the barrier membrane and also between the neighboring endosteum and the bony wall of the scala tympani but not in the lumen of the scala tympani (cases 1 and 2). 2 Blood and exudate lined the round window membrane and the under surface of the basilar membrane in case 2, but no blood cells were found in the center of the scala tympani. Only under intravital pressure could blood and exudate force their way under the endosteum of the bony wall and the round window membrane along such an extensive circuitous route. 3 The dense reticulum of the cochlear aqueduct was found to be well preserved in these specimens up to the cochlear opening of the aqueduct. This again testifies in favor of the pathologic nature of the displacement of the barrier membrane. 4 In case 3 the accumulation of blood located just under the ruptured portion of the separating membrane points to a causative relationship between increased spinal fluid pressure and rupture of the barrier membrane.

Many times blood can be traced through the fundus of the internal auditory meatus and the modiolus into the perilymphatic spaces of the cochlea after subarachnoid hemorrhages.<sup>4</sup> Oddly enough, previous workers did not claim that physiologically the spinal fluid flows along the nerve and vessel canals of the internal auditory meatus into the cochlea. If the fact that blood has passed through the cochlear aqueduct is accepted as proof of the latter's patency, so the fact that blood has passed through the modiolus should prove that spinal fluid passes via nerve and vessel canals.

In case 6 the cochlear aqueduct of the left temporal bone was completely obliterated in its narrow portion, measuring 0.6 mm in length by newly formed Paget bone. In order to avoid technical errors, all the consecutive serial sections, measuring 16 to 22 microns in thickness, were studied. In spite of the complete obstruction of the aqueduct, blood was found in the cochlear opening of this structure. In this temporal bone the absence of blood in the lower, wide portion of the aqueduct, below the level of the obstruction, is additional proof that the blood inside the scala tympani of the cochlea did not pass through the aqueduct. Therefore, the fact that blood has been seen in the "typical" location at the cochlear opening of the aqueduct should not invariably be considered as evidence that it passed through the aqueduct from the subarachnoid spaces.

Complete bony obliteration of the narrow portion of the aqueduct was found on the right side in case 6. There was, however, no evi-

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4 Animal experiments designed to clarify this question have been undertaken

dence of blood in the scala tympani. The fact that blood was present in the wide portion of the right cochlear aqueduct below the level of the obliteration is noteworthy. It indicates that there is a regular flow of spinal fluid which at times may carry blood into the cochlear aqueduct. It does not necessarily mean that spinal fluid reaches the perilymphatic spaces under physiologic circumstances. In this particular instance the cochlear aqueduct was obliterated in both temporal bones,



Fig 7—Hemorrhage (*h*) may be seen in the scala tympani (*st*) of a rabbit killed with chloroform. Note the absence of blood in the cochlear aqueduct (*ca*), in the basal and second cochlear turn (*ct*) and in the internal auditory meatus (*iam*).

but blood was present in the scala tympani of the left side only, where an intracochlear hemorrhage originating from the spiral ligament was evident. This case supplies additional evidence almost with the clarity of a well planned experiment against the free flowing of spinal fluid through the cochlear aqueduct.

The round window membrane did not show any pathologic displacement in case 6. Were there a normal flowing of spinal fluid

through the cochlear aqueduct into the perilymphatic spaces of the cochlea, one would expect some change in the position of the round window membrane. This membrane represents, in addition to the short and firm ligament of the stapes, the only soft part of the perilymphatic spaces capable of yielding to increased or decreased perilymphatic pressure.

The blood found in the cochlear aqueduct and in the cochlea in case 6 was most probably of agonal origin. There is experimental evidence supporting this explanation. In rabbits killed with chloroform, massive hemorrhages are occasionally seen in the scala tympani while the cochlear aqueduct, the internal auditory meatus and the subarachnoid spaces are devoid of blood. Blood found in the perilymphatic spaces of these experimental animals is beyond doubt of intracochlear origin (fig 7). It is noteworthy that both in rabbits and in human material the regions of the spiral ligament and the basilar membrane are the most frequent sites of hemorrhages. Although all animals were killed with the same technic, only a small number of them showed intracochlear hemorrhages. Microscopic studies, however, failed to explain why agonal hemorrhages are so rare in both human and rabbit cochleas.

The observation that blood is present in the cochlea following subarachnoidal hemorrhage may be explained in one of two ways. 1. A sudden increase of the spinal fluid pressure may have ruptured the barrier membrane at the cochlear entrance of the aqueduct and opened a pathologic pathway for the spinal fluid. 2. An agonal intracochlear hemorrhage may have occurred. Therefore, the presence of blood in the scala tympani of the cochlea associated with subarachnoid hemorrhage should not be accepted as proof of a physiologic flowing of spinal fluid into the perilymphatic spaces via the cochlear aqueduct. Previous concepts of the physiology of the cochlear aqueduct, however, were based on evidence of such pathologic specimens.

Under physiologic conditions a diffusion, if any, between spinal fluid and perilymph is more likely to take place through the barrier membrane than by simple flowing of spinal fluid into the scala tympani. The separating membrane described seems to be a normal histologic feature of the cochlear aqueduct in a great number of cases and probably represents a barrier between spinal fluid and perilymph.

Additional experimental studies free of artefacts are indispensable in order to clarify fully the physiology of the cochlear aqueduct.

## SUMMARY

A membrane separating the lumen of the cochlear aqueduct from the perilymphatic space of the cochlea is demonstrated in human fetuses for the first time

This separating membrane, about 0.001 mm or less in thickness, is demonstrated in adult human temporal bones. The name "barrier membrane of the cochlear aqueduct" is proposed for this structure.

In cases of subarachnoid hemorrhage a pathologic rupture of the barrier membrane caused by a sudden increase of pressure of the spinal fluid seems to precede the hemorrhagic penetration of the cochlea.

Blood may be present in the perilymphatic spaces of the cochlea even if the cochlear aqueduct is completely obliterated by bone.

The fact that blood had been seen at the cochlear entrance of the aqueduct after subarachnoid hemorrhage cannot be accepted as evidence of a physiologic flowing of spinal fluid into the cochlea.

Histologic evidence points to a fluid exchange, if any, that takes place by diffusion through the membranous barrier, rather than to a direct flowing of spinal fluid into the cochlea. Additional experimental studies free of artefacts are necessary to clarify the question of patency of the cochlear aqueduct.

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## Case Reports

### FOREIGN BODY OF THE MIDDLE EAR

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**F**OREIGN BODY of the external auditory canal is not uncommon, and an occasional patient is encountered who has succeeded in getting a foreign body into the middle ear by this route. In all cases the foreign body of the middle ear has arrived there by way of the canal except for a few instances of knife wounds and bullets. The foreign bodies found include beads, stones, insects, pencil erasers, various vegetables, buttons, a ball of cotton and bits of metal from welding.<sup>1</sup> The literature on puncture wounds of the mouth and throat is sparse.<sup>2</sup> Innumerable objects have caused injuries of this type, but the injuries usually heal quickly and without complication. A search of the literature, however, has not revealed any instance of a foreign body of the middle ear that had arrived there by way of the mouth.

#### REPORT OF A CASE

This remarkable feat was accomplished when the patient fell down the front steps of his house onto the sidewalk, on his face. He had been smoking a pipe. When the patient recovered from his initial shock, he found that there was considerable pain in the right side of the face, he was deaf in the right ear, the right side of his face was paralyzed, and several of his back teeth had been knocked out by the injury. He also noticed that his pipe was broken in half and that the stem was missing. After several hours, because of the persistence and severity of the pain, he went to a nearby hospital.

There he received symptomatic medication and penicillin. A lower molar tooth which remained but which had been loosened by the injury was removed on the ward by a member of the house staff. A biopsy was made of buccal mucosa from the wound of entrance and was reported as showing acute and chronic inflammation. A roentgenogram of the skull was reported as revealing fracture of

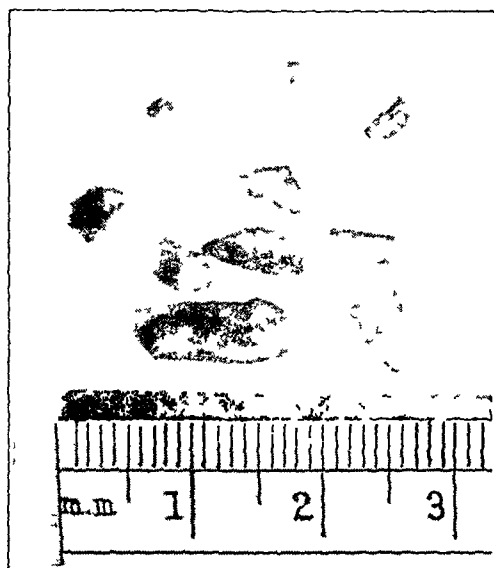
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1. Maulder, T. J. Foreign Body in Mastoid Antrum, *Proc. Roy. Soc. Med.* **14**: 26, 1920. Longer, E. P. Two Interesting Foreign Body Cases of the Mastoid and Nose, *Ann. Otol., Rhin. & Laryng.* **38**: 1158, 1929. Mosher, W. F. Foreign Bodies of External Canal, Middle Ear and Mastoid and Their Complications, *Arch. Otolaryng.* **36**: 679 (Nov.) 1942.

2. Klimpfel, W. Puncture Wounds of Mouth and Throat, *Ztschr. f. Hals, Nasen u. Ohrenh.* **45**: 328, 1940. Amano, K. W. Pipe Stem Impacted in the Tonsil for Fifteen Months, *Arch. Otolaryng.* **23**: 429 (April) 1936.

the right zygoma with undisplaced fragments. Two examinations of the ear were made, and the only finding was that the lumen of the external auditory canal was occluded by clotted blood. The patient had a temperature of 100 F during the first three days of hospitalization and then remained afebrile for the next two weeks. He was discharged improved, with a diagnosis of (1) fracture of the zygoma, (2) bleeding into the canal of the facial nerve, causing facial paralysis, and (3) cerebral concussion. Two days after his discharge, he succeeded in picking the greater portion of the pipestem out of the muscles of his cheek. Despite this, he continued to have pain, malaise, asymmetry of the face and deafness, so that he applied to, and was admitted to, the Veterans Hospital at Fort Howard, Md.

At the time of his admission he had a low grade fever, a moderate amount of redness and swelling over the right mastoid process and a purulent discharge of the right ear. Penicillin therapy was begun by the officer of the day in the belief that this was acute mastoiditis.



The foreign bodies removed from the patient's ear.

An otolaryngologic examination was made the morning after admission. He had considerable residual inflammation over the mastoid bone. The external auditory canal was markedly narrowed by an inflammatory reaction. The lumen of the canal was filled with nonodorous pus, and when this was removed, an irregular, hard, black foreign body could be seen to be impacted in the swollen canal, partially covered with buds of granulation tissue.

Roentgenograms of the mastoid processes showed them to be large and cellular, with no exudate and no alteration of the normal pattern. A roentgenogram did show some roughening of the superior surface of the condyloid process of the right mandible. The foreign body was radiolucent and could not be demonstrated by the usual routine roentgen view or by one taken with the patient in the Stenver position. No evidence of fracture of the zygoma was seen in these films.

Audiometric examination revealed complete nerve deafness, and the results of tuning fork tests were confirmatory. He had complete paralysis of the affected side of the face. Neurologic examination gave otherwise negative results. In the buccal mucosa just behind the molar teeth could be seen the healing wound of entrance of the foreign body.

After repeated unsuccessful attempts had been made to remove the foreign body through the canal, a radical mastoidectomy was performed by a postaural approach. When the mastoid antrum was opened, the malleus and the incus were found free in the cavity. When the middle ear was exposed, eleven small fragments of the bit of the pipistem were disclosed. The lining of the middle ear was overgrown by a mossy covering of granulation tissue, so that identification or evaluation of the essential pathologic changes was difficult. A Panse flap plastic operation was done. The cavity of the operative wound was packed with gauze soaked in tyrothricin solution, and the skin was closed with interrupted silk Stewart stitches.

The postoperative course was uneventful, and except for a small amount of serosanguinous drainage during the first few weeks, the ear remained dry. The patient has been observed on occasions for fourteen months. During this interval, he has experienced a moderate return of function of his facial muscles, so that his face is symmetric and he is able to close his eyes. His loss of hearing has remained complete. It is interesting that he retained some labyrinthine function. This was discovered accidentally when he experienced vertigo and nystagmus while the ear was being irrigated with penicillin solution that had recently been removed from the refrigerator.

The probable path of the foreign body was through the buccal mucosa, between the medial surface of the ramus of the mandible and the lateral pterygoid plate of the sphenoid bone, grazing the superior surface of the condylod process, through the anterior wall of the mandibular fossa into the middle ear. The facial nerve was probably injured by the foreign body scraping over its superficial and relatively unprotected course on the floor of the middle ear.

## MULTIPLE OSTEOMA OF THE MASTOID CAVITY

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**O**STEOMA of the mastoid process is infrequent,<sup>1</sup> multiple osteoma occurring within the mastoid cavity is rare.<sup>2</sup>

### REPORT OF A CASE

H. B., a white man aged 39, was admitted to the hospital because of acute nasopharyngitis. On routine examination, a swelling was noticed behind the right ear in the mastoid area (fig. 1). It was not painful or tender to touch, in fact, the patient was not aware of its presence. The auricle was pushed slightly forward. Both external auditory canals were dry and clean. Both drums were intact and had a normal appearance. Hearing was not affected in either ear. There was no history of any infection of the ear or of "ear trouble."

Roentgenograms showed a well developed normal pneumatic mastoid bone on the left side. On the right, there was a large "expanding lesion," the size of the entire mastoid process, containing six separate small osteomas (figs. 2 and 3).

A diagnosis of osteomas of the mastoid process was made, and an operation was performed.

The usual elliptic incision of the skin was made, which revealed an elevation of the cortex of the mastoid bone. Chiseling through the outer table, which was thin and easily removed, one discovered an already existing large cavity in the mastoid process, which gave the impression that a complete simple mastoidectomy had already been performed.

The inner table was pearly white and smooth except for the six small bony tumors, each about the size of a pea and firmly attached by a broad base, arranged in a circle (fig. 4). The bony tumors were removed with little difficulty and no bleeding, leaving a concave base pedicle. There was no pus or fluid in the mastoid cavity. The soft tissue and the skin were sutured tightly, and healing occurred uneventfully.

The pathologic report was as follows: "The gross specimen consists of six masses of bony tissue, the largest measures 1.5 by 1 by 0.5 cm. and the smallest 1 by 0.5 by 0.5 cm. They are grayish white and are markedly irregular in shape.

"Microscopic examination reveals completely necrotic islands of what appears to be ghostlike osteoid tissue.

"Diagnosis: Necrotic osteoid tissue."

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<sup>1</sup> Coates, G. M. Osteoma Growing from the Mastoid Cortex, Arch. Otolaryng. 28:27-28 (July) 1938.

<sup>2</sup> Friedberg, S. Osteoma of the Mastoid Process, Arch. Otolaryng. 28:20-26 (July) 1938.

ABSTRACT OF THE AVAILABLE LITERATURE<sup>3</sup>

Osteoid osteoma is a benign neoplasm, which represents a displacement of the normal bone tissue by osteoid tissue and calcified vascular

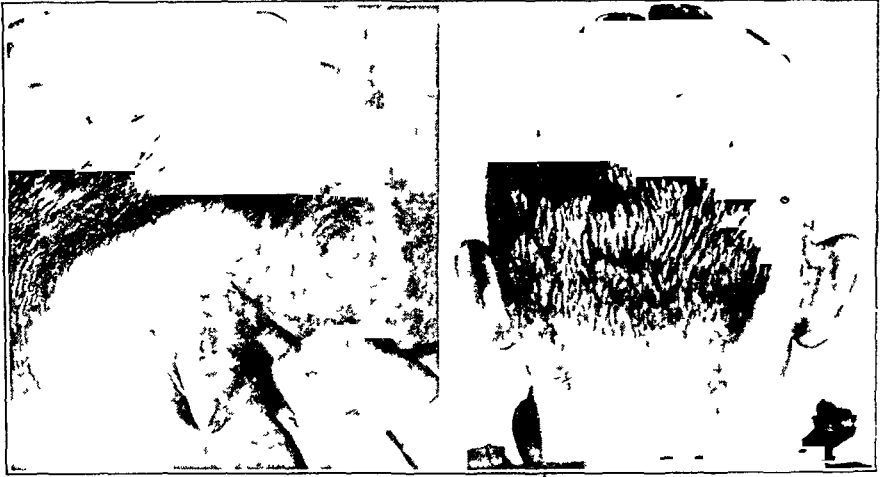


Fig 1—Lateral and posterior views of a patient with multiple osteoma of the right mastoid process

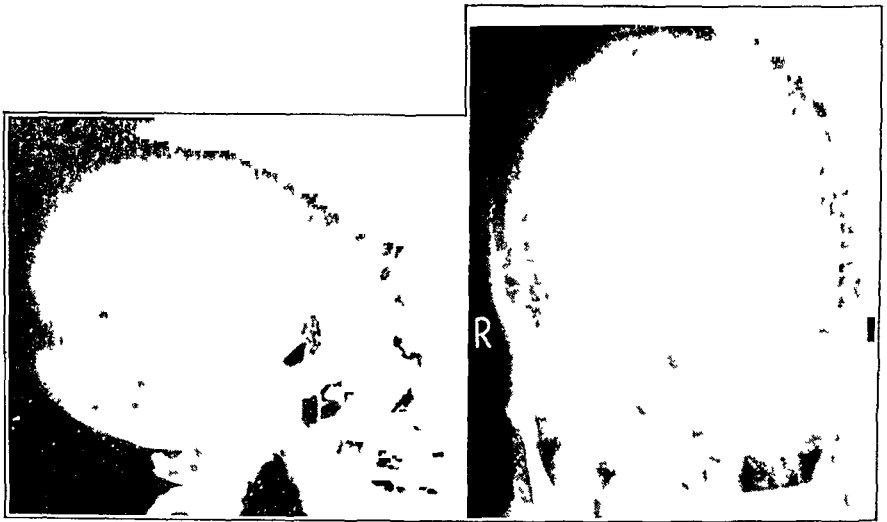


Fig 2—Roentgenographic views of the osteomas occupying the right mastoid cavity

connective tissue surrounded by a variable zone of sclerosis with or without periosteal new bone formation

3 Hempstead, B. L. Osteomas of the Paranasal Sinuses and Mastoid Process, *JAMA* **111** 1273 (Oct 1) 1938. Jaffe, H. L., and Lichtenstein, L. Osteoid Osteoma, *J Bone & Joint Surg* **22** 645 (July) 1940. Kleinberg, S. Osteoid Osteoma, *New York State J Med* **43** 332 (Feb 15) 1943.



Fig 3—Roentgenographic appearance of the involved right mastoid cavity compared with that of the normal left

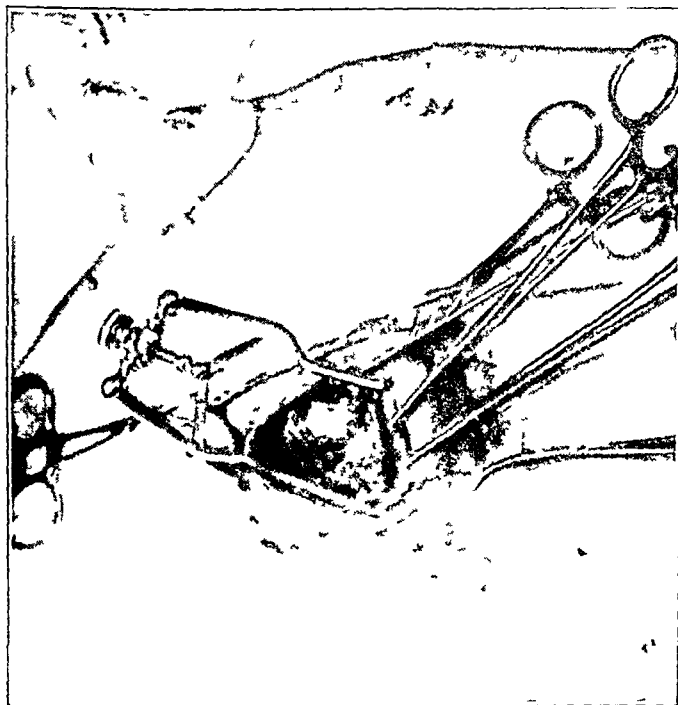


Fig 4—This photograph, taken at operation, shows a small osteoma (white object) within the mastoid cavity

Osteoma of the mastoid should not be confused with exostosis of the external auditory canal.<sup>4</sup> The latter condition invariably arises from the tympanic portion of the temporal bone, and its anatomic situation alone distinguishes it from osteoma of the mastoid process.<sup>5</sup>

*Classification*—Gross specimens of osteoma have been classified as

1 Nonmovable type, with a broad base, firmly attached. This type constitutes the largest percentage.

2 Movable type, sometimes having a pedicle or a pseudarthrosis.

3 Movable, unattached type.

Microscopically, osteoma has been found to be of four types.

1 Osteoma compactum or eburneum.

2 Osteoma cancellare.

3 Osteoma cartilagineum.

4 Osteoma mistum.

Osteoma compactum or eburneum is more frequent than the other types. It is hard, ivory-like, spherical and attached to the cortex of the mastoid process. It may even penetrate into the cells of the mastoid process. Histologically, it shows dense, lamellated bony tissue traversed by a few vessels.

Osteoma cancellare is exceedingly rare. It consists of cancellous bone plus fibrous cellular tissue.

Osteoma cartilagineum is not common and has been reported by many writers. It consists of bone cartilage.

Osteoma mistum is a mixture of the types of bone found in osteoma eburneum and osteoma cancellare.

*Etiology of Osteoma*—Tillmanns and Dobbeau stated that these tumors arise from embryonal tissue.

Campbell stated that it is probable that these tumors arise from mesosseous connective tissue, just as the normal bones of the head and face form in the embryo without interposition of cartilage.

Simpson stated that there is considerable evidence that the origin of the usual osteoma of the mastoid process is from mesosseous connective tissue rather than from remnants of cartilage.

Stuart suggested that the tumor may be due to some pituitary influence.

Friedberg considered trauma with subsequent ossifying periostitis and chronic inflammation as predisposing factors.

Pryesse stated that the constitutional and glandular condition of the patient is the cause.

Trauma and infections may have some bearing on the condition.

*Diagnostic Observations*—This condition occurs in young adults. The tumor is usually slow growing and produces an external deformity. Pain when present is localized over the site involved. The condition has not been and is not associated with fever. Roentgenographically it presents itself as a relatively radiolucent or rarefied area.

4 Simpson, W. L. Osteoma of the Mastoid, *Arch. Otolaryng.* **32**: 642-661 (Oct.) 1940.

5 Stuart, E. A. Osteoma of the Mastoid, *Arch. Otolaryng.* **31**: 838-854 (May) 1940.  
Cinelli, A. Osteoma Eburneum of the Mastoid, *ibid.* **33**: 421-424 (March) 1941.

of bone, either round or oval, surrounded by what appears as a more or less opaque or dense zone

*Treatment*—Surgical removal is the method of choice and gives prompt clinical cure without recurrence. Complications practically never result from its presence or from its operative removal.

*Résumé of Cases Reported in the Literature*—Ten patients had suppurative otitis media in the affected ear, 17 had no suppuration. The macroscopic and the microscopic picture were practically the same in both types, and the final results were also the same in both types of cases.

Probably no connection exists between suppuration of the mastoid process as an etiologic factor and the formation of osteoma.

In 5 of the aforementioned cases there was obstruction of the meatus acusticus externus due to the nearness of the tumor to this canal. The condition was relieved by removal of the growth.

In almost all cases reported the osteoma was single and was found growing external to the cortex.

The sizes varied from that of a small hazelnut to that of a small chicken egg.

#### COMMENT

This case is reported because there were no cases recorded in the literature available to me in which the osteoma was multiple and located within the mastoid cavity, arising from the inner table of the mastoid process, and not on the external cortex.

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## SUBLINGUAL RHABDOMYOMA

T E BEYER, M D

AND

J R BLAIR, M D  
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**R**HABDOMYOMAS are of special interest to the otolaryngologist because of their comparative rarity and because the majority occur in or about the oral cavity

Parreira and Nunes de Almeida<sup>1</sup> found only 2 cases in a histologic study of 4,720 specimens at the Portuguese Institute of Oncology Klemperer<sup>2</sup> in a comprehensive review of the literature up to 1933 found 37 cases, in 22 of which the tumor occurred in the tongue To these 37 cases he added 6 of his own, in 1 of which the tumor occurred in the tongue

The predilection of rhabdomyoma for the tongue and the oral cavity suggests that trauma may be an etiologic factor Added weight is given to this view by 4 cases in which the epithelium overlying the tumor was found to be cancerous<sup>3</sup>

The histology of rhabdomyoma has been exhaustively studied by Abrikossoff,<sup>3a</sup> Dewey,<sup>4</sup> Thoma<sup>5</sup> and others<sup>6</sup> and will therefore not be repeated here The consensus is that they are usually benign and that metastases are rare

The diagnosis of rhabdomyoma is usually established only after removal of the tumor, as distinctive clinical and roentgenologic features suggestive of the true nature of the lesion are generally lacking

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1 Parreira, H , and Nunes de Almeida, J Rhabdomyoma of the Tongue, *Arq de pat* **6** 582, 1934, Rhabdomyoma of the Tongue Two Cases with Review of Cases Previously Reported, *Rev port de estomatol* **5** 69 85, 1939

2 Klemperer, P Myoblastoma of Striated Muscle, *Am J Cancer* **20** 324, 1934

3 (a) Abrikossoff, J A Weitere Untersuchungen uber Myoblastenmyome, *Virchows Arch f path Anat* **280** 723, 1931 (b) Schirmer, R Ueber ein Myoblastom zusammen mit Cancroid der Zunge, *Beitr z path Anat u z allg Path* **89** 613, 1932 (c) Derman, G L, and Golbert, Z W Ueber Unreife aus der quergestreiften Muskulatur hervorgehende Myome, *Virchows Arch f path Anat* **282** 172, 1931 (d) Dawydow, I Zur Frage der unausgeriften Rhabdomyome des Kehlkopfs, *Ztschr f Hals , Nasen u Ohrenh* **30** 221, 1931

4 Dewey, K L Rhabdomyoma of the Tongue, *Arch Path* **3** 645 (April) 1927

5 Thoma, K H Rhabdomyoma of the Tongue, *Am J Orthodontics (Oral Surg Sect)* **27** 235, 1941

6 Boyd, W Surgical Pathology, Philadelphia, W B Saunders Company, 1942, p 733 Ewing, J Neoplastic Diseases, *ibid* , 1940, pp 240 248

In the case under discussion a growing tumor under the tongue produced difficulty in mastication and swallowing, which necessitated its removal

#### REPORT OF A CASE

A 52 year old railroad conductor first noted a painless swelling under the symphysis of the mandible in the winter of 1944. For the next year this swelling was intermittent and seemingly often associated with exposure. In February 1946 the patient began to experience difficulty in keeping his lower denture in place, and the dislocation of the tongue made mastication, swallowing and even talking increasingly difficult.



Fig 1—Left Photograph showing the tongue displaced upward and to the right. Right Postoperative photograph showing the tongue returned to its normal position.



Fig 2—Left Anterior posterior sialogram showing Wharton's duct displaced laterally by a tumor mass. Right Lateral sialogram showing an enlarged normal submaxillary gland.

The patient had worn upper and lower dentures for the past twelve years without discomfort.

Except for a train injury to his pelvis in 1919, he had had no previous injuries or serious illnesses.

Physical examination revealed a firm, ovoid, dark red tumor about the size of a large walnut in the floor of the mouth on the left side. The mucosa covering

this mass appeared normal. Wharton's duct was normal in size and caliber. The tongue was displaced upward, backward and to the right (fig 1, left). The hypopharynx and larynx, owing to the backward dislocation of the tongue, could not be visualized. The left submaxillary gland was palpably enlarged.

A sialogram showed Wharton's duct to be of normal size and caliber and free of foreign bodies, but pushed up and backward (fig 2). Except for being enlarged the submaxillary gland appeared to be normal.

Repeated incisions of the tumor resulted in brisk bleeding but had no permanent effect on its size or consistency. A course of roentgen irradiation was without appreciable benefit. Accordingly, on June 11, 1946, with the patient under 'pentothal sodium' anesthesia, the tumor was removed by blunt dissection. The ends of Wharton's duct which had been torn were approximated, and the wound was closed without drainage. Recovery was uneventful.

The pathologic diagnosis was sublingual rhabdomyoma.

Several weeks after the operation, routine examination disclosed a tumor about 3.5 cm in diameter in the left hypopharynx which had escaped previous notice.

This tumor was attached in the glossopharyngeal angle and rested on the epiglottis.

On September 4 this was removed by dissection and snare and the left tonsil was removed.

The gross specimen consisted of a tannish brown mass of tissue removed from the region of the tonsil. The mass measured 3 cm in its greatest dimensions. The sectioned surface was homogeneously tannish brown. Microscopic examination of this nodule revealed it to consist of cells of a large type with a distinct cell wall and a peripherally placed nucleus and in some instances showed distinct cross striations. Among the cells were many thin-walled blood vessels. Fat stains failed to reveal free fat within the cells. Microscopic examination of tissue from the tonsil showed partial to complete fibrous tissue replacement of lymphoid tissue.

The diagnosis was rhabdomyoma of the hypopharynx, histologically benign and fibrosis of the tonsil.

Because of persistent enlargement, the left submaxillary gland was removed on September 9. This showed chronic inflammation with fibrosis and atrophy of acini.

When the patient was last examined Jan 22, 1947, there was no evidence of recurrence of the tumors (fig 1, right). He was wearing his dentures comfortably and had no complaints.

#### SUMMARY AND CONCLUSIONS

Rhabdomyoma in or about the tongue may cause obstructive symptoms requiring its surgical removal.

Roentgen therapy was without curative value in this case.

Sialography proved to be a valuable adjunct in the differential diagnosis.

Fibrosis of the submaxillary gland resulted from prolonged compression of Wharton's duct.

227 Sixteenth Street

## Abstracts From Current Literature

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### Ear

THE PROBLEMS OF TINNITUS IN THE PRACTICE OF OTOLARYNGOLOGY ALBERT P SELTZER, *Laryngoscope* **57** 623 (Sept) 1947

Seltzer discusses some of the theories of the production of tinnitus aurium. The most usual causes are listed. There are many means of treatment, which are discussed. The results are anything but startling, and some modes of treatment are of no value whatsoever. Each case must be studied individually. More emphasis should be placed on treating the person as a whole than on treatment of the head noise itself.

HITSCHLER, Philadelphia

SOME OBSERVATIONS ON TUMOR OF THE ACOUSTIC NERVE BERNARD C MEYER, *New York State J Med* **47** 2436 (Nov 15) 1947

Meyer reports on '40 odd cases' from the neurologic services of Mount Sinai Hospital, New York. He refers to the profundity of Cushing's observations, published some nineteen years ago, and adds 'some features not mentioned in Cushing's book'. These are: increase of spinal fluid protein, hypertension in 12 of 37 (blood pressure above 149 systolic and 90 diastolic), electroencephalographic findings which ranged from normal to a point which suggested focal lesions. On the whole, the last was considered to be nonspecific. Auditory symptoms preceded all others and were of the classic order, with tinnitus, diminished hearing, vertigo and cerebellar symptoms. Motor twitchings were occasionally confused with jacksonian epilepsy, and were seen in face and eyelid on the affected side. The ages of the patients ranged from 17 to 65. The youngest patient reported by Cushing was 21. In a few patients a loss of the corneal reflex was the only sign of involvement of the trigeminal nerve. Usually there was no facial asymmetry, although the facial nerve was found at autopsy to be compressed or prolonged.

Surgically, the question arises as to intracapsular or extracapsular removal. There are advocates of both methods. Cushing preferred the conservative intracapsular procedure, although he seems to have thought recurrence more likely. The Mount Sinai surgeons found mortality lower and recurrences fewer after intracapsular removal. When total extirpation was done, facial paralysis always followed. Cushing felt that the psychic depression of the patient with facial paralysis was sometimes worse than a recurrence which required a secondary operation.

VOORHEES, New York

ROLE OF BONE CONDUCTION IN THE EFFECTIVENESS OF HEARING AIDS J L VECKMANS, *Acta oto rhino laryng belg* **1** 321, 1947

In cases of transmission deafness the hearing aids tend to amplify too much the low pitched sounds, with resulting distortion of speech and undue exaggeration of the background noises. The author thinks that attention of the lower tones

and more marked amplification of high tones give better intelligibility, he disagrees with those who hold the opinion that one should realize a selective amplification (i.e., greater amplification of tones definitely lost and less of those better conserved)

HERSON, Chicago

## Pharynx

VITAMIN K AND LATE TONSILLAR HEMORRHAGE SAMUEL L FOX AND G BROOKS WEST  
Jr, Laryngoscope **57** 564 (Aug) 1947

Fox and West studied the controversial subject of post tonsillectomy hemorrhage in relation to the action of vitamin K and that of salicylates, especially a chewing gum containing acetylsalicylic acid

It is believed that salicylates produce hypoprothrombinemia and that simultaneous administration of vitamin K will prevent that. However, the hypoprothrombinemia produced by even large doses of salicylates was not of a degree sufficient to cause bleeding. The use of the chewing gum did cause increased postoperative bleeding. Vitamin K did not prevent this.

The conclusion was that the bleeding present in the cases in which the patient used Aspergum was caused by some local rather than systemic action.

HITSCHLER, Philadelphia

POLIOMYELITIS AND TONSILLECTOMY CLAUDE D WINBORN AND JOHN R STANSBURY,  
Laryngoscope **57** 575 (Aug) 1947

Additional evidence is submitted concerning the relation of tonsillectomy and poliomyelitis.

The authors conclude that no more of those who had undergone the operation contracted poliomyelitis but that, of those contracting the disease, a greater proportion suffered with the bulbar type. They noted that poliomyelitis occurred in a much smaller proportion of tonsillectomized persons in a nonepidemic period than in an epidemic period.

HITSCHLER, Philadelphia

PLASTIC REPAIR OF THE PHARYNGOSTOMY R J L ROBIN, Rev de laryng **277** (June) 1947

The author reviews different technics applied to the pharyngostomy consecutive to Portmann's laryngectomy in three stages. The latter procedure, although requiring protracted hospital care, appears to make possible surgical cure in extensive forms of extralaryngeal cancer and reduces markedly the postoperative bronchopulmonary complications.

The secondary plastic closure of the pharyngostomy is made on the average one to three months after laryngectomy. Depending on the primary incision of the skin, the pharyngostomy is either vertical (i.e., fusiform or oval shaped) or triangular. The fusiform stoma is closed by means of a simple sliding flap from the immediately adjoining skin. The oval and the triangular stoma may be high or low, if high, it is closed by means of the rotating Indian flap cut horizontally from the submental region and brought down vertically over the stoma, if low, it is closed by means of a double sliding triangular flap after Imre.

In cases of extensive openings, comprising the whole height of the neck, one uses a combination of the aforementioned procedures—i.e., the Indian flap for the upper part of the stoma the first month, and Imre's flap the second month.

In cases in which there is marked scar formation around the stoma one uses a delayed pedicle flap taken from the suprascapular or the pectoral region.

HERSON, Chicago

## Larynx

NEW CONCEPTS OF THE ETIOLOGY AND TREATMENT OF DIVERTICULA OF THE ESOPHAGUS B. T. KING, Surg., Gynec. & Obst. **85** 93 (July) 1947

King does not accept the standard explanation that congenital weakness of the pharyngoesophageal wall predisposes to the development of esophageal diverticula. He directs attention to the small ridge at the site of all intervertebral joints and states that the lower border of the cricoid cartilage frequently rests against the ridge of the joint of the fifth cervical vertebra. This ridge continuously pressing against the lower border of the cricoid cartilage causes thinning of the inferior constrictor muscle and the posterior esophageal wall at the point of contact. The upper border of the posterior surface of the cricoid cartilage does not rest against the spine, as does the lower portion, and it is in the latter region that the herniation occurs. The greater muscular development in males, with the consequence that the larynx impinges more firmly on the spine, is said by the author to account for the threefold greater frequency of diverticula among men.

The other concept proposed concerns the closure following amputation of the sac. A narrow blade forceps is placed across the neck of the sac at the point of junction so as not to interfere with or include any of the circumferential wall of the esophagus. Another forceps is placed parallel to the first, and the sac is amputated between the two. Closure is begun with the first forceps, *in situ*, and a running suture is employed. The forceps is removed and the suture continued to the other side of the amputated sac. The suture must not be pulled to the extent of causing any puckering of the closure. A second similar row then enfolds the first. The resulting closure is preferable to the transfixion and ligation suture, which may cause narrowing or a partial stricture. A one stage operation is advocated.

FRIEDBERG, Chicago

CARCINOMA OF THE LARYNX: METHODS AND RESULTS OF TREATMENT G. B. NEW, F. A. FIGI, F. L. HAVENS AND J. B. ERICH, Surg., Gynec. & Obst. **85** 623 (Nov) 1947

This article is based on a study of 568 patients treated for malignant laryngeal neoplasms at the Mayo Clinic during a ten year period, 1934 to 1943, inclusive. The difficulty of distinguishing malignant tumors of the larynx from certain benign growths and from tuberculoma or syphiloma on visual inspection alone is mentioned, and biopsy of every laryngeal tumor is held essential. For this procedure, suspension laryngoscopy is used routinely, and frozen sections are obtained. Should the specimen prove unsatisfactory, another piece of tissue can be removed or treated immediately. The grading of malignancy according to Broder's classification is a most important factor in the selection of treatment in each case of laryngeal carcinoma.

Four methods of treatment are employed (1) thyrotomy (laryngofissure) and surgical removal of the growth, (2) laryngectomy, (3) removal or treatment of the local lesion under suspension laryngoscopy and (4) external irradiation. In deciding which is the most suitable method of therapy in the individual case one considers size, the location and the extent of the laryngeal growth, the grade of malignancy, the pressure or the absence of extralaryngeal extensions or of metastases involving cervical nodes, and the age and the general physical condition of the patient.

Complete removal of the neoplasm is the prime consideration in any of the operative procedures, but unnecessary sacrifice of the voice should be avoided, a radical operation should not be employed when a conservative one will remove the neoplasm equally well and will leave the patient with a good functional voice, nor should a conservative operation be used when a more radical procedure is indicated. The authors consider that it is unjustifiable to try a conservative form of treatment on the assumption that, if the results are not good, something else can be attempted later.

The type of tumor which is ideal for thyrotomy (laryngofissure) is of low grade malignancy and is confined to the anterior two thirds of a vocal cord which is freely movable. The fact that a growth extends across the anterior commissure does not preclude the possibility that it may be extirpated by thyrotomy.

All patients who have intrinsic laryngeal carcinoma with fixation of one or both cords but no evidence that the lesion has metastasized to the cervical nodes are subjected to laryngectomy, provided their general condition will permit. However, unless extremely small, a high grade carcinoma involving a vocal cord should be treated by laryngectomy, even though there is no cord fixation. This statement is based on the fact that active epithelioma may often extend far beyond the apparent limits of the growth.

A small low grade epithelioma of vocal cords which are not fixed can be removed by surgical diathermy under suspension laryngoscopy, with good results. This statement applies to a small group of selected cases. If the neoplasm cannot be brought under direct view in its entirety or if there is any question as to the extent of the growth, thyrotomy should be performed. A well circumscribed and low grade malignant tumor of the epiglottis, the aryepiglottic folds or the base of the tongue can be treated by electrocoagulation under suspension laryngoscopy. Often after removal of a malignant tumor the base of the lesion is treated by insertion of radon seeds. Preliminary tracheotomy is carried out in all these cases.

Irradiation is reserved for high grade, radiosensitive lesions that are too extensive to warrant their being treated by surgical measures. It is employed infrequently by the authors. Preliminary tracheotomy is performed whenever intensive roentgen therapy is to be used.

Of the 568 patients in the series, 78.5 per cent were treated by surgical methods and 21 per cent by irradiation. Of the patients who underwent surgical treatment and could be traced, 73.5 per cent survived five years or more without recurrence. In the laryngectomized group 60.2 per cent had a five year cure, 83.6 per cent of the traced patients who underwent thyrotomy lived five or more years, in the group treated by surgical diathermy or insertion of radon seeds, under suspension laryngoscopy, 91.7 per cent lived five or more years. In the group treated by irradiation only 6.9 per cent showed a five year survival. The authors admit that the low survival rate of patients treated by irradiation is to be expected since practically all the patients had inoperable lesions which were considered hopeless when first examined.

ERRORS AND DIFFICULTIES IN EXTRACTING FOREIGN BODIES FROM THE BRONCHUS AND THE ESOPHAGUS C FERNANDEZ F, *Rev de otorrinolaring* **7** 22 (March) 1947

The author presents a group of 5 patients who had a foreign body either in the trachea or in the esophagus. The purpose of the presentation was to illustrate some of the difficulties and complications that arose in the treatment of these patients. These difficulties were occasioned by a number of factors: 1 Removal of the foreign body was attempted by an untrained person. 2 In several cases faulty and improper instruments were employed. 3 Extreme carelessness was exhibited in the failure to localize the foreign body. In several of the cases there was lack of a preoperative roentgen examination. 4 Negligence arose in the postoperative follow up studies. In one of his patients a large retropharyngeal abscess developed twelve days after a bronchoscopic examination. 5 There was failure to employ the proper anesthetic in a number of the cases reported.

The presentation is worth while, since it is a frank indictment of members of the medical profession, for there are times when physicians become hasty, over zealous and overconfident in meeting these acute critical problems. This is an excellent warning that each case must be carefully studied, evaluated and followed to complete termination with the greatest amount of care.

PERSKY, Philadelphia

## Nose

NASAL HEMORRHAGE H E HARRIS, *Eye, Ear, Nose & Throat Monthly* **26** 81 (Feb) 1947

A method is presented for the control of the severe type of epistaxis, which usually originates in the posterior half of the nose and usually requires packing of the anterior and posterior parts of the nose.

A small curved metal suction tube is covered with a tight fitting rubber catheter, with the metal tip protruding slightly at the distal end. A short wave electrosurgical unit is then used, and, with one electrode attached to the patient's skin, the circuit is completed by touching the other electrode on the exposed metal at the proximal end of the suction tube. In this manner blood is aspirated rapidly from the bleeding area, which can then be located and the bleeding vessel electrocoagulated. It may be necessary to slow the bleeding temporarily by inserting a pack saturated with a 10 per cent solution of cocaine hydrochloride containing epinephrine hydrochloride.

By this method, nasal hemorrhage of the massive severe type has been controlled in 43 cases during the past seven years. Ligation of the internal maxillary or the external carotid artery has not been found necessary. A short discussion of the blood supply of the nose is included.

JENNES, Waterburg, Conn

USE OF NEW AGENTS IN THE TREATMENT OF EPISTAXIS B A COPE and M M HIPSKIND, *Eye, Ear, Nose & Throat Monthly* **26** 417 (Aug) 1947

The gelatin sponge and oxidized cellulose are utilized in the treatment of epistaxis to avoid causing discomfort to the patient by the use of bulky packing. Since these agents do not have to be removed, the possibility of fresh nasal hemorrhage on removal of the packing is obviated.

The bleeding point is visualized with the help of gentle suction with a capillary tip. A local anesthetic agent may be used. A small gelatin sponge is cut to



a size which will allow it to cover the site of the bleeder and at least 3 to 5 mm extra surface around the site of bleeding. This pack is then introduced over the bleeding area and is held in place for a few moments while the edge of the sponge is tamped down to the mucous membrane. The pack usually disappears in about four to five days, either by being absorbed or by being picked or blown out by the patient. It is sometimes difficult in the Kesselback Little area to get the sponge to stick, but in these cases of nonadherence it can usually be found that part of the sponge is on the cutaneous margin of the columella.

Where pressure is also needed, as in some cases of bleeding from the posterior portions of the nose, oxidized cellulose is used. In the most common sites of epistaxis, the gelatin sponge is preferable, both from ease of application and rapidity of action in controlling the bleeding.

CHANGING CONCEPTS OF SINUSITIS. F. JOHNSON PUTNEY, *Laryngoscope* **57** 664 (Oct) 1947

Putney reviews the present concepts of sinusitis. He classifies cases of sinusitis as allergic, mechanical and bacterial, and discusses each class.

NEW ACQUISITION OF MEDICINE IN THE PROCESS OF RHINOSINUSITIS. ALEJO P. BELOU, *Rev argent de oto rino laring* **15** 338 (Sept-Oct) 1946

The author presents a detailed description of the problems encountered in the treatment of rhinosinusitis. He groups these under (1) aeration and ventilation of the nasal cavities, (2) destruction or inhibition of the germs, (3) reaction of the body, and (4) protection of the useful mucous membrane and elimination of the degenerated mucosa.

He describes the pathologic process of the mucous membrane of the nose and accessory sinuses. He discusses the various medicaments commonly employed in shrinking the edematous mucous membrane to afford proper aeration and drainage. Difficulties arising in a speedy cure are often due to many anomalies of the structure of the various sinuses and of the nose.

In dealing with the inhibition and destruction of the various organisms, the author enters into considerable detail in regard to the various sulfonamide compounds, stressing their evolution from the earliest products to the present accepted preparations that are more commonly employed. He describes the various methods of treatment, including both the parenteral and the local application. Locally he commonly uses the displacement method of Proetz after the preliminary decongestion of the mucous membrane. Instilling of solutions of sulfonamide drugs into the larger sinuses, such as the frontal, sphenoid and maxillary sinuses, has definitely shortened the course of infection and lessened the dangers of complications. However, emphasis is placed (1) on danger of the clinical symptoms and (2) on the danger that some germs may become sulfonamide resistant and may continue to produce symptoms of a low grade nature which can flare up on the slightest provocation. The contraindications to the use of sulfonamide drugs are hepatic infections and severe blood dyscrasias. The role of penicillin and its effectiveness are discussed. This antibiotic is administered both parenterally and locally. The author recommends that 10,000 to 20,000 Oxford units be given by intramuscular injection every three hours in cases of acute disease. More recently the action of penicillin has been prolonged through the use of a preparation of the substance in oil. Locally the penicillin can be instilled into either the maxillary or the frontal sinuses in doses of 3,000 to 5,000 units. This instillation may be repeated every three hours, and when this procedure is used, the author

employs an indwelling catheter or cannula. In the treatment of the acute or the subacute infections of the ethmoid sinus he employs the Proetz technic. Some of the untoward effects of penicillin are dermatitis, allergic reaction, fever and chills, various generalized pains, including headaches, muscular pains and colicky pains, and, finally, transitory azotemia.

The author also recommends that tyrothricin be used locally in the sinuses—an antibiotic which has given splendid results, particularly in cases of osteomyelitis.

To increase the general resistance of the patient, a diet is stressed, since in sinus infections, particularly during the acute stage, there is an increase in the basal metabolism, and hence the caloric intake should be increased. There are often a nitrogen disturbance, a water imbalance and a decrease in the normal functioning of the digestive tract. The author recommends a diet high in calories and an increase of the vitamin intake, stressing particularly ascorbic acid, and an increase of the mineral intake, but advises that the diet be of a bland nature, so that the digestive tract may function freely. The author always recommends the use of autogenous vaccines, particularly in the cases of chronic infection. Elimination of any allergic factor is extremely important.

Surgical treatment is indicated purely to preserve a normal mucous membrane and to remove any part of the mucous membrane that has undergone permanent pathologic changes. In conclusion the author makes the following observations: 1. Chemotherapy and antibiotic medication are efficacious factors for the control of the sinus infections, 2. Failure to obtain good results is due principally to incomplete study of the patient and indiscriminate use of medication, 3. Careful bacteriologic study is important, so that the proper medication can be employed for the destruction of the organisms, 4. At present the most satisfactory treatment includes the use of penicillin, 5. It is necessary to increase the natural defenses of the body by a proper dietary regimen and vitamin therapy, 6. It is necessary to establish a normal state of the mucosa and proper drainage of the cavities, 7. Antibiotic medication is the best means of curing the sinuses, but surgical intervention may still be necessary to clear up many irreversible pathologic conditions in the sinuses.

PENICILLIN THERAPY IN SINUSITIS. SANTIAGO A. ARANZ AND ALFREDO R. CORDERO, *Rev argent de oto rino laring* 16:1 (Jan-Feb) 1947.

The authors outline their method of administering penicillin in the treatment of acutely infected sinuses. They administer penicillin both locally and parenterally. Locally they instil penicillin into the maxillary sinuses, the frontal sinuses or the sphenoid sinuses as indicated by the pathologic conditions. Their method is to insert into the sinus either a cannula or an antrum puncture needle and permit it to remain in situ during the entire period of treatment. At regular intervals the sinus is irrigated through this cannula or needle with about 100 cc. of water containing 2,000 units of penicillin. The treatment continues as long as the suppuration persists. The solution is retained in the sinus cavity for at least one half hour. Treatment is repeated every three or four hours except for the fact that with the earlier treatments the authors used from 10 to 20 cc. of solution. The only difficulties encountered with this method of treatment are as follows. Occasionally, when the walls of the sinuses are extremely thick, it may be difficult to introduce the needle or the cannula, a mild ulceration may occur on the septum near the tip of the nose or on the inferior border of the nostril, dermatitis may be caused by the adhesive tape which holds the cannula in place, occasionally there may be obstruction of the needle or the cannula.

Penicillin is also administered parenterally in adequate doses, i.e., about 5,000 units per cubic centimeter of solvent is injected intramuscularly at the usual three hour intervals

In a series of 82 cases, maxillary sinusitis was treated in 67, bilateral in 13, frontal sinusitis in 8 and pansinusitis in 2. The total quantity of penicillin usually amounted to 500,000 units per patient. The average length of treatment was five days. Within the first twenty four hours there was an appreciable decrease or complete disappearance of pain, which was due to the better drainage and aeration of the sinuses. There was also a marked improvement in the general condition of the patient, including a definite fall in temperature. In conclusion the authors state in regard to the acute infectious process that complete cure was effected in 100 per cent of the cases. When there was an acute exacerbation of a chronic infection, the acute state was immediately cleared up but the chronic lesion was unaffected. In chronic infections of the sinuses the treatment did not produce any favorable results.

PERSKY, Philadelphia

OSTEOMYELITIS OF THE FRONTAL BONE. ATILIO VIALE DEL CARRIL, *Rev argent de oto rino laring* **16** 17 (Jan Feb) 1947

The author describes the mechanism of infection and osteomyelitis of the frontal bone and some of the problems associated with both the pathologic conditions, the complications and the treatment. Under treatment he stresses the importance of early extensive surgical excision not only of all the visible pathologic tissue but also of apparently normal bone beyond it. This treatment should be supplemented with the administration of both sulfonamide drugs and penicillin. The latter can be used locally, a solution containing 1,000 units of penicillin per cubic centimeter can be instilled through a drainage tube into the operative area. Parenterally penicillin is given in doses of 20,000 to 30,000 units every three hours. Since these newer drugs have appeared, the prognosis of osteomyelitis has improved immeasurably, and the therapeutic problem depends on two factors: (1) curative (surgical treatment associated with both parenteral and local administration of penicillin and sulfonamide drugs, and local application of tyrothricin), (2) prophylactic (prolonged desensitization with autogenous vaccines).

PERSKY, Philadelphia

### Miscellaneous

PLASTIC SURGERY IN INDUSTRY. C. L. STRAITH AND M. A. PILINC, *AM J SURG* **74** 328 (Sept) 1947

The authors' method of treating a crushing injury of the nose is to elevate the depressed bones with a flat instrument, such as a chisel or a periosteal elevator, then to support them by packing the nasal cavity with petrolatum gauze. A special apparatus is described and illustrated, for maintaining fixation until the fragments are firmly united. For correction of a saddle nose, preserved homologous rib cartilage is used, together with methods of rhinoplasty not notably different from those in general use.

PLASTIC OPERATION FOR HARELIP PROFILE A RITHI, J Internat Coll Surgeons  
10 381 (July Aug) 1947

When harelip is associated with a curved nose, as it often is, the author corrects the nose first and then shortens and thickens the upper lip. The technic is carried out with the patient under local anesthesia. Seven drawings and photographs serve to demonstrate the excellence of his operative results.

ALBERT P SELTZER, Philadelphia

SPIROMETRIC EVALUATION OF BETA DIMETHYLAMINOETHYL BENZHYDRYL ETHER HYDROCHLORIDE (BENADRYL) IN ASTHMA L LEVY II and J H SEABURY, J Allergy  
18 244 (July) 1947

Spirometric methods afford a simple and reliable means of judging the quantitative effects of various drugs used in the treatment of asthma. Subjective evaluation of any drug given to the asthmatic patient is of little scientific significance. Spirometric studies were performed on 16 patients thirty minutes after oral administration of 100 mg of diphenhydramine hydrochloride ("benadryl hydrochloride"). When compared with the initial spirometric tracings, those obtained after treatment showed no consistent changes in vital capacity, tidal air, minute ventilation, expiratory differential, respiratory rate or degree of emphysema.

After epinephrine and aminophylline had been administered to 5 of these 16 patients, there was a uniform increase in vital capacity, tidal air, minute ventilation and expiratory differential and no increase in the respiratory rate.

Six of the patients derived subjective benefit, with decrease in dyspnea, from the use of "benadryl." The spirometric data for 3 of these were directly opposed to the subjective report. In 1 patient the response obtained was the same as that observed after the administration of epinephrine and aminophylline.

Since epinephrine and aminophylline afford both subjective relief and objective spirometric evidence of improvement in most asthmatic patients, the authors feel that these drugs should be used as a base line by which newly introduced drugs for which bronchodilator effects are claimed may be quantitatively evaluated.

FRIEDBERG, Chicago

'PYRIBENZAMINE' VERSUS SPECIFIC HYPOSENSITIZATION IN THE TREATMENT OF POLLINOSIS A COMPARATIVE STUDY C E ARBESMAN, V L COHEN and H OSGOOD, J Allergy 18 311 (Sept) 1947

The treatment of ragweed hay fever with tripelennamine hydrochloride ("pyribenzamine hydrochloride", N' pyridyl=N' benzyl=N=dimethylethylene=dimine hydrochloride) alone was, in the authors' experience, as effective as the usual injection treatment for the relief of symptoms in clinic patients. Injection therapy plus the use of the usual symptomatic drugs, such as iodides, ephedrine and aminophylline, proved superior to the administration of tripelennamine hydrochloride alone in the alleviation of bronchial symptoms. There is no question regarding the value of antihistaminic drugs as used in the treatment of ragweed or hay fever. Tripelennamine hydrochloride alone, in sufficient dosage, may control the symptoms of seasonal allergic rhinitis to a great degree, but it cannot give as adequate relief as does proper hyposensitization plus administration of tripelennamine hydrochloride. The incidence of side effects of this drug is low when the drug is given with specific hyposensitization, because smaller doses are required to control the symptoms.

FRIEDBERG, Chicago

THE INTELLIGIBILITY OF CONNECTED DISCOURSE AS A TEST FOR THE "THRESHOLD FOR SPEECH" G A TALCONER and H DAVIS, *Laryngoscope* **57** 581 (Sept) 1947

An interesting test is described for measuring loss of hearing. It consists in measuring the threshold of intelligibility of connected discourse (TICD). The patient listens to monitored connected discourse. He himself adjusts the loudness to the point at which he is just able to understand everything said. The setting is recorded.

The test is quick (two minutes) and reliable (it was compared with the standard test for threshold of speech hearing, in which monosyllabic words are used), it is interesting and not fatiguing to the patient. Its chief disadvantage is the subjective nature of the determination of the end point. Few, however, recorded erroneous thresholds.

This test should prove to be of great clinical value.

HITSCHLER, Philadelphia

THE USE OF ANTIBIOTICS IN THE TREATMENT OF BACTERIAL INFECTIONS W BARRY WOOD JR, *Laryngoscope* **57** 657 (Oct) 1947

Penicillin is effective against gram positive micro organisms (particularly the gram positive cocci). It is effective in the treatment of syphilis and in that of certain highly fatal diseases, such as pneumococcal meningitis, empyema, subacute bacterial endocarditis, acute osteomyelitis and thrombosis of the cavernous sinus.

Streptomycin is effective against gram negative bacilli, such as the colon bacillus, "Friedlander's bacillus" and *Hemophilus influenzae*, and in tularemia. Streptomycin produces more toxicity than penicillin. Vertigo and deafness have been encountered frequently.

The pharmacologic aspects, the dosage and other principles of antibiotic therapy are discussed.

HITSCHLER, Philadelphia

REGIONAL SPEECH DIFFERENCES IN VETERANS AND NONVETERANS BURTON H BYERS, *Quart J Speech* **33** 312 (Oct) 1947

Twenty three nonveterans, mostly women, and 28 veterans, mostly men, ranging in age from 17 to 35 and in classification from freshman to junior at Henderson State Teachers College, were observed for variations from the general American dialect. The results showed an increasing elimination of the more easily recognizable dialectic differences on the part of the veterans. The author states that further study would probably indicate a correlation between length of service and the modification of speech differences, and between general intelligence and the extent to which regional differences were modified.

PALMER, Wichita, Kan

A STUDY OF ENCEPHALITIS MILDRED GOTTDANK and DORIS TREPPEL, *Quart J Speech* **33** 355 (Oct) 1947

This article comprises a review of the medical background of encephalitis and a report of a case in which an ambulatory patient with chronic encephalitis was aided in the speech clinic for eighteen months. The symptoms of 'a postencephalitic adult' coming to the speech clinic will be a combination of one or more of

the following (1) tremors, (2) drooling, (3) a masklike expression, (4) bizarre posture, (5) definite symptoms of a disturbance of speech. A patient with chronic encephalitis finds himself burdened with physical, social, vocational and economic problems, to which are added, for the most part, the additional ones of vocal and articulatory difficulties. In the case presented, the patient showed tremor of the left arm, masklike expression, infrequent blinking, stooped posture and uneven gait. The voice was monotonous, lacking variation in pitch and rate, and was almost inaudible. The rhythm was irregular, and the patient seemed to find difficulty in verbalizing his thoughts. There was apparently poor lip and lingual mobility which made articulation sluggish, although there was good control of lingual and labial muscles. The breathing was somewhat shallow, and the entire speech pattern lacked animation. The patient appeared frightened during interviews, and it was impossible to put him at ease. He stated he had always needed speech training but had never had the courage to go to a clinic for help. The technics used consisted of practice of reading exercises, use of the voice mirror, and development of good phonation. When phonation became habitual, lip and tongue exercises were begun, the patient being encouraged to articulate clearly individual sounds and later words, phrases and sentences. After this, work with pitch, rate and intonation was begun. Question and answer practice was carried out many weeks. Finally the subject was placed before a mirror, and many facial expressions were tried out and used. When he was discharged, emotional and psychologic integration was at least well on its way to successful completion. On discharge he was able to speak of his difficulty with ease and objectivity and was free from destructive self consciousness. He still had a fixed expression to some extent, occasional difficulties of thought and, during fatigue, immobility of the lips. Both clinic and patient were satisfied with the results. It seems reasonable to believe that there are many other ambulatory patients with chronic encephalitis who could benefit by speech reeducation.

PALMER, Wichita, Kan

CONTRIBUTIONS FROM THE MILITARY PROGRAMS IN VOICE COMMUNICATION. WILLIAM B McCORD, *Quart J Speech* **33** 370 (Oct) 1947

The material developed from the work done by the Army Air Forces in voice communications and speech intelligibility is useful to the public as well as to the speech clinic for improving speech communications in noise. In general the following factors and suggestions were found to be most effective: 1. Speak loudly, but don't shout. 2. Use a moderate tempo; prolong the sounds, especially in important words or phrases. 3. Group words into short phrases—don't talk word by word. 4. Emphasize in a steady, natural manner but limit the variation of pitch, loudness or tempo. 5. Speak distinctly, work to be understood. 6. Make your speech sound natural and meaningful. 7. Learn to use your particular communication equipment with maximum efficiency. (a) Speak directly into the mouth piece, receiver or microphone, with the lips lightly touching it. (b) If using ear phones, wear them directly on the ears. (c) Turn the volume up as high as possible when the voice signal is weak. 8. Practice listening in noise. 9. Develop standardized procedures if possible, using standardized nomenclature and pronunciations.

Many of the teaching programs in the military services were widely acclaimed for their remarkable accomplishments. Much of the rapid learning was due to the unusual motivation based on (1) the urgency of the situation, (2) the controlled, concentrated study, and (3) the clarification of goals.

CANCER AND POLITICS, THE OPERATION ON GROVER CLEVELAND M G SEELIG, Surg Gynec & Obst **85** 373 (Sept) 1947

In 1893 one of the most dramatic surgical operations in American history lent color to a period that was packed with sufficient explosive tinder to alarm the best and most patriotic minds of our people. The patient was Grover Cleveland, the President of the United States. The operation was the removal of the left side of the upper jaw, which was the seat of cancer.

Shortly after Cleveland won his second election for the presidency, a number of economic factors were responsible for great unrest in the country. Heavy gold exportations by the United States, the suspension of free coinage of silver by India, the lack of confidence in public credit due to the gold shortage in the treasury, the fear of a silver basis, unwise speculation and general unemployment all made for critical times. A disastrous panic occurred on June 27, 1893. President Cleveland had called a special session of Congress for Aug 7, 1893, to repeal the Sherman Silver Purchase Act.

On June 18, 1893, Dr R M O'Reilly, who later became Surgeon General, examined the President and discovered an ulcer of the left side of the hard palate. A biopsy was pronounced to be highly suggestive of cancer by the pathologist of the Army Medical Museum (the name of the patient had been kept secret). Dr Joseph D Bryant, of New York, was called to see the President and advised an immediate operation. Every circumstance connected with the incident was shrouded from both the members of Congress and the public at large. Dr W W Keen was also called in consultation.

At different times of the day and the night of June 30, 1893, all parties concerned boarded a private yacht lying in New York harbor. The utmost secrecy surrounded the proceedings. On the morning of July 1, with the yacht sailing at half speed up the East River, an operation was performed. Under nitrous oxide anesthesia the two upper left bicuspid teeth were extracted. Ether was then substituted and with Drs Keen and Erdmann assisting, Dr Bryant removed the entire left side of the upper jaw from the first bicuspid to beyond the last molar tooth. The antrum was found to be partly filled by a gelatinous mass. Bleeding was controlled with pressure, hot water and the galvanocautery.

The operation required approximately one hour, and an estimated 6 ounces (150cc) of blood were lost. The President was out of bed on the second day after the operation. The pathologic diagnosis was sarcoma. On July 17 another operation was performed because of the fear that remnants of the tumor had escaped removal. The defect of the palate was corrected by means of an artificial jaw made of vulcanized rubber.

On August 5, just twenty days after the second operation, the President arrived in Washington to direct the strategy of the repeal of the Sherman Law. Authorities in the field of history are said to concede that, had Cleveland's opponents been aware of his physical condition, the gravity of the national consequences would have been unpredictable.

Grover Cleveland died fifteen years after the removal of his jaw. The cause of death was recorded as heart failure, complicated with pulmonary thrombosis and oedema. It is known that Mr Cleveland had suffered from a gastrointestinal disorder and that he died of intestinal obstruction. It has been impossible to determine whether death was due to abdominal cancer. If it was, one might speculate whether the lesion was an independent primary growth or a metastatic lesion. The latter possibility is extremely doubtful.

# Society Transactions

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## CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

• John R. Lindsay, M.D., *President*

Lawrence J. Lawson, M.D., *Secretary*

*Regular Monthly Meeting, Dec 1, 1947*

### **Benign Cysts of the Paranasal Sinuses** Presented by DR. HAROLD F. SCHUKNECHT

Benign cysts of the paranasal sinuses are of two general types, those which take origin from the sinus mucosa and those which invade the maxillary sinuses from the teeth. From the mucosa arise three types. The nonsecreting cysts, the mucous gland (retention) cysts and the mucocoeles.

Nonsecreting cysts are found in the maxillary sinuses and occur in about 5 per cent, as shown by routine roentgenograms. On roentgenograms they produce a characteristic dome shaped shadow, but may also fill the sinus and produce complete homogeneous clouding. The cyst forms as a collection of straw colored fluid in the loose subepithelial connective tissue of the mucosa. This fluid is usually sterile and coagulates on standing. Small nonsecreting cysts usually produce no symptoms and need not be removed. When the cyst occupies one half or more of the sinus, there may result not only local symptoms but general symptoms of fatigue, irritability and headache. Having no epithelial lining, this cyst may disappear after spontaneous rupture or after puncture and lavage. Or cure may be obtained by an antrum window operation, with part or all of the cyst wall being removed through the window. Occasionally a radical removal of the contents of the sinus is necessary.

The mucous gland (retention) cysts occur in all the sinuses. They are small, not individually evident on roentgenograms, have an epithelial lining and appear as part of the histopathologic picture in chronic hyperplastic sinus mucosa. Hyperplasia of the epithelium of the duct of the tuboacinosal gland is probably an important factor in producing stenosis with resulting retention of secretion and cyst formation. At the time of operation these small cysts are often misinterpreted as being small abscesses.

Mucocoeles occur commonly in the frontal and ethmoid sinuses. Obstruction of the nasofrontal duct or of a particular ethmoid ostium probably occurs in all cases of true mucocoele. Repeated acute infections, in some instances accompanied by temporary blockage, appear to increase the probability of eventual permanent blockage and mucocoele formation. As the products of secretion, inflammation and desquamation accumulate in the cystic space, the latter expands to encroach on the nasal cavity, the orbit and the anterior cranial fossa. The cyst invades the orbit early by pressure erosion of the floor of the sinus, with characteristic proptosis and lateral and downward displacement of the eye. Acute infection of a mucocoele (pyocoele) may be a serious complication if the cyst has expanded into the anterior cranial fossa. Chronic mild infection of a mucocoele may result in chronic hyperplastic osteomyelitis, in which case the cystic space may be almost filled with new bone. An intranasal operation may be adequate, however, usually a radical external frontal ethmoidal sinusotomy is necessary. An opening into the nose must be created which will remain open.



Odontogenic cysts are of two types the follicular cyst and the radicular (root) cyst. The follicular cyst arises from the enamel organ epithelium of the dental follicle. When one or more teeth are present, it is commonly termed a dentigerous cyst. The cyst will not contain a tooth if it develops from the enamel epithelium before this has become sufficiently differentiated to form enamel. The lining epithelium is stratified squamous in type and closely resembles oral epithelium. As the cyst expands, it may invade and fill the maxillary sinus. If a tooth is present in its wall, it may be displaced into the sinus. The radicular cyst develops from the apical or root granuloma. Epithelial cell rests of the periodontal membrane may be included in the root granuloma and by inflammatory stimulation may completely line the central cystic space as it forms. Radical removal of the sinus contents is necessary for both types of odontogenic cysts, for which the Caldwell Luc operation is generally best suited.

#### DISCUSSION

DR. WALTER THEOBALD: I wonder if many of these cysts do not get well with simple lavage. I have found that after irrigation and finding a cyst present, with return of straw colored fluid, on later irrigation the cyst wall itself may wash out the opening or into the middle meatus so that it can be removed. I think, furthermore, that the window operation does suffice in the majority of cases for removal of these cysts.

DR. SAMUEL SALINGER: What is the significance of the simple inclusion cyst so far as the patient is concerned? It has been my experience that in most cases it causes little trouble and is often discovered accidentally on routine roentgen examination. Frequently it disappears spontaneously and occasionally is punctured during irrigation of the antrum. In my opinion it is not significant unless it attains sufficient size to block the ostium. The case of the mucocele is entirely different, this should be removed. The question as to what procedure is best is a matter for another discussion.

DR. JOHN R. LINDSAY: These nonsecreting cysts have interested me for some time, probably because I have encountered a few which were not so benign as had been thought. Cultures of the straw-colored fluid were usually sterile. My associates and I made a chemical study of these fluids a few years ago, the fluids have a high protein content, corresponding to exudates rather than transudates. When they are small, perhaps less than half filling the sinus, they are probably innocent. Yet I have had the experience of puncturing one cyst with a lumbar puncture needle and withdrawing about 10 cc. of fluid, and the next day finding the patient in bed with acute arthritis. I have had other experiences in which simply letting the fluid out relieved acute pain in the region of a joint. In other instances there was no evidence that the cyst was producing symptoms. Some will disappear after irrigation. They do not have an epithelial lining and may collapse and disappear. Others recur and require an antrum window operation to permit removal, still others require radical antrotomy for adequate removal. I have observed cases in which a window operation had to be followed by radical exenteration of the mucosa of the sinus to prevent recurrences and relieve the accompanying distress. When there is evidence of much hyperplastic change of the mucosa, in addition to the cyst, it is better to do the radical operation than to risk having to do a second operative procedure.

DR. MAURICE F. SNITMAN: Does Dr. Schuknecht include cystic adenoma among the benign cysts of the upper jaw or the maxillary sinus?

DR. SHERMAN SHAPIRO: Do these benign cysts ever undergo cancerous degeneration?

DR HAROLD I SCHUKNECHT Dermoids frequently involve the nasal structures, but rarely the paranasal sinuses proper I think the only type that becomes cancerous is the follicular cyst Kahn, in 1933, reported several cases in which the follicular cyst apparently developed into adamantinoma

### Fundamental Changes of Concepts in Regard to Chronic Suppurative Sinusitis Presented by DR HENRY L WILLIAMS, Rochester, Minn

In the last twenty-five years more fundamental changes have taken place in the organized body of concepts that form the philosophy of chronic suppurative disease of the paranasal sinuses than in any other division of otorhinology These conceptual changes fall into two groups The first group includes those concerning the clinical pattern of chronic suppurative disease of the paranasal sinuses Formerly, chronic suppurative sinusitis was thought to be characterized by severe pain in the head or headache, and long papers were devoted to the description of the headache pathognomonic of suppuration of certain particular sinuses, it was considered to be due to pressure of retained secretion on the wall of the sinus

As a result of investigative work by Thomas Lewis, Kellgren, H G Wolff and his co workers, and Behnke, it is now generally recognized that as a rule, chronic suppurative sinusitis is a painless disease Exceptions that "prove the rule" do occur, and it is important to recognize them clinically

When chronic suppurative sinusitis co exists with clinical evidence of chronic vasomotor rhinitis, however, the condition is quite different This combination of disorders I term "chronic hyperplastic sinusitis" The clinical pattern is characterized by prominence of the symptom of headache Because patients who have allergic involvement of the paranasal sinuses without symptoms and signs of suppuration are seen in whom the symptom of headache is a prominent clinical feature, and because pain in the head (or headache) is an unusual clinical feature in patients with uncomplicated chronic sinusitis, it seems reasonable to conclude that headache in a patient with chronic hyperplastic sinusitis results from the allergy rather than from the suppuration By clinical examination it can then be ascertained that the headache does not arise from the sinuses but usually from other pain sensitive structures about the head, as a rule the cranial and cervical musculature and the extracranial blood vessels It would appear, then, that to secure clinical relief equal attention must be given to both the allergic and the suppurative factors

The so called routine allergic management of hyperplastic sinusitis has proved disappointing Positive results of skin tests rarely give specific information, generally indicating only that the patient under consideration is pathergic, attempts at obtaining relief by specific desensitization usually fail In chronic hyperplastic sinusitis, diagnosis by means of elimination diets also has proved ineffective The author believes these failures to result from the fact that in this syndrome what is presented generally is not an antigen antibody type of reaction but, rather, so-called physical allergy, for which the term 'pathergy' has been suggested by Urbach This disturbance appears to be failure of the general adaptation reaction described by Selye, the normal physiologic process proceeding no further than the stage of "alarm" Because of cellular injury, histamine is released in the alarm reaction, producing a clinical picture indistinguishable from that of "allergy"

It is imperative that the allergic treatment of a patient with such sinusitis be carried out by, or in close association with, the rhinologist So called nonspecific allergic treatment is usually more successful in relieving the allergic symptoms than so called specific methods Among nonspecific methods are included subcutaneous injection of foreign proteins, such as typhoid bacilli and milk, and the

use of house dust The low dosage method of Hansel is favored Symptomatic relief has been obtained for a number of patients by the use of capillary vasodilators such as monoethanoleamine nicotinate ("nicamin"), sodium nicotinate, nicotinic acid, histamine, neostigmine, magnesium sulfate and the like "Nicamin" is preferred because of ease of administration

Certain rhinologists maintain that there is an allergic factor present in nearly all cases of chronic suppurative sinusitis At the Mayo Clinic, microscopic examination of sections of mucosal lining and other tissue removed at operation in cases in which chronic suppurative sinusitis had been diagnosed almost invariably revealed an inflammatory picture, thus confirming the so called allergic picture The role of the eosinophil in allergy is unknown, and it is questionable if its presence in examined tissue is a sufficient basis for an unqualified diagnosis of allergy

Formerly, it was felt that free and adequate drainage of the rigid walled cavities was the prime consideration, and to this end the functioning structures of the nasal chambers, the mucosa and the turbinal tissues were freely sacrificed Thirty years ago Lillie was one of the first to protest against this indiscriminate surgical practice Under his guidance, physiologic investigations were undertaken by Hansel, Stark, Heeterdicks, Hilding and others Proetz, Van Alyea and others have added greatly to the knowledge of nasal function and its importance to well being It is now generally accepted that while adequate drainage must be secured, even more important is preservation of the functioning nasal tissues It is now generally recognized that operative procedures should be adequate to achieve drainage and aeration, and at the same time rational enough to preserve the functioning structures of the nose In the condition defined as chronic hyperplastic sinusitis a judicious combination of surgical and allergic treatment must be used to give symptomatic relief

Several technical changes in operations on the various sinuses have resulted from this changing philosophy There is a trend toward use of the nasoantral window in operations on the maxillary sinus, in most instances removing the lining mucosa is contraindicated The ethmoid sinuses are almost invariably involved along with other sinuses, in simultaneous involvement of the maxillary and the anterior ethmoid sinus, a nasoantral window frequently is sufficient to relieve both disturbances In suppuration of the frontal and ethmoid sinuses, however, exenteration of the ethmoid sinuses is necessary to afford access to the frontal sinus Chronic frontoethmoid suppuration, in my opinion, does not lend itself to preservation of the mucosa of the frontonasal duct as proposed by Van Alyea In most instances reactive osteitis tends to produce progressive constriction of the fronto-nasal duct, occasionally resulting in formation of a pyocele As a rule, therefore, intranasal frontoethmoid exenteration is the procedure of choice, though external frontoethmoid exenteration requires less skill and experience and is potentially less dangerous Another reason in favor of the intranasal procedure is the greatly diminished tendency for scar tissue to close the nasofrontal opening, one of the principal causes of failure in external operations on the frontal sinus This is due to wide destruction of the frontal process of the nasal bone and removal of the lamina papyracea of the ethmoid bone, as usually practiced in the Lynch technic The first procedure allows collapse of soft tissue into the approach to the fronto-nasal opening, while removal of the lamina papyracea favors formation of excessive granulation tissue from the periorbita, with subsequent closure of the frontonasal opening by scar

External operation on the frontal sinus is justified when the disease has perforated one of the walls of this sinus with formation of an abscess or a fistula

also when there is evidence of partitioning in the frontal sinus by bony laminae, or in cases in which reactive osteitis has so hardened the bone in the area that dangerous force would be necessary in performance of an intranasal procedure.

Continuance of the external incision around the inner canthus of the eye favors involvement of the venous plexus around the lacrimal sac, the importance of which in promoting spreading osteomyelitis of the frontal bone and osteitis of the facial bones has been pointed out by Lillie With the use of tantalum foil, shaped to fit the frontonasal opening at the time of operation, I have found that closure of this aperture can be avoided.

#### DISCUSSION

DR O. E. VAN ALYIA The society is indeed fortunate to have Dr Williams give his ideas about the changing philosophy and conception of sinus disease. I agree heartily with almost everything he has said. All who do much work in the fields of rhinology and laryngology are becoming "allergy minded." As is often the case, however, when a new idea takes hold, there is a rush to put it into practice, and it becomes a fad with many people who overlook the wide range management of the conditions concerned. The reports from dust desensitization have been amazing. Yet are not otolaryngologists somewhat inclined to regard every patient as allergic, overlooking some other fundamental factors in the disease and in the symptom complex?

In surgical procedures on the frontal sinus, Dr Williams displays a leaning toward intranasal methods when possible. Of course, it has always been consistent to include with procedures on the frontal sinuses exenteration of the anterior ethmoid sinuses. I have never been able to understand why the whole group of ethmoid cells needs to be sacrificed. It is true that certain cells en route to the frontal sinus, frontal cells or ethmoidofrontal cells, near the ostium, are of major importance. In my opinion one should give up the idea of removing bullar cells, they never block the frontal sinus, and one disturbs an area which may be free of infection. However, cells which do block drainage must be removed, by passage of a cannula or otherwise. Those in the lumens of the sinuses may be taken care of through the external frontal approach without disturbing the sinus or the ostium.

During the past few years my associates and I have studied some old sections removed by radical operations in such cases and find, amazingly enough, that the sections obtained in these cases contained a preponderance of eosinophils. The results of surgical intervention were temporary, many of the patients are now wrecks due to chronic nasal disease. Those of them that we still see occasionally in the dispensary are trying to get relief from symptoms that are now worse than they were before resort was made to radical surgery.

Penicillin in my hands has been a failure as administered by the Proetz method and I now reserve it for patients that have serious symptoms, for which it is indicated.

Dr Williams did not mention the "irreversible" changes referred to constantly in the literature. I have not encountered any. My experience has been similar to his when the antrum is opened by a window procedure and thickened membrane is found. Recovery takes place when drainage is established. Is this an irreversible change? One hears frequently of little abscesses between the sinus and the bone. In our examination of specimens we failed to find any abscesses in extirpated mucosa, nor did we find ulcers and other conditions that have been described.

Another item Dr Williams failed to mention is the so called ethmoiditis. We see conditions of multiple polyposis of the middle meatus, yet on examination of specimens from the anatomic laboratory, polyps in the middle meatus are usually seen to arise from the maxillary ostium, the uncinate process and the bulla. I have yet to find one in which polyps could be traced to the ethmoid labyrinth.

DR SHERMAN SHAPIRO I should like to ask Dr Williams if he considers that complete obliteration of the frontal sinus can be achieved by any method short of removal of the entire anterior wall and anterior floor, including the septum. I should also like to ask if there is any postmortem material at the Mayo Foundation or elsewhere showing that obliterated frontal sinuses have remained so.

DR SAMUEL SALINGER To the older men in this audience this subject is of extreme interest because they have seen a remarkable evolution in the general concept of sinus disease, the younger men know only half the story. The other half is buried in textbooks, voluminous literature and the memory of "has been." I well recall when discussions were confined solely to surgical procedures, with argument as to which was best. The volume of surgical treatment of the sinus was tremendous. One member of this society reported that he had performed intranasal frontal sinusotomy with the rasp three hundred times. My own predecessor, Dr Otto Freer, was strong for a motor driven burr with special curets of his own. The Halle operation was widely employed, often with disastrous results. Then came the external frontoethmoid eventeration, which was extensively employed and of which one hears little of late!

The trend to conservatism has been definite and unmistakable. Year by year in my own practice I do fewer and fewer operations, and so called radical sinusotomy is becoming almost as rare as the simple mastoidectomy. Increasing knowledge of the physiology of the nose and of the constitutional factors giving rise to nasal symptoms have explained many of the bad results which formerly followed operation.

I agree with Dr Williams that allergy studies have often proved disappointing except in certain types of cases. We have found the results more significant in children and adolescents than in adults, probably owing to nutritional and endocrine factors.

There is one item I should like to stress. The time to begin treatment of chronic sinusitis is when the acute attack subsides. Otolaryngologists are prone to dismiss patients too soon. It is important at this time to check the sinuses thoroughly, ascertain their functional capacity and examine the patient for factors which might predispose him to future attacks with increasing damage to the lining mucosa.

I should like Dr Williams, if he will, to state more explicitly just what he considers the proper indications for intranasal antrostomy.

DR MAURICE F. SNITMAN In a study of more than 200 specimens of nasal mucosa removed during radical sinusotomy my associates and I found typical chronic inflammation present in only 2 instances. In most cases the microscopic picture was that of edema associated with varying degrees of eosinophilia.

DR G. H. MUNDT It seems to me there are some indications for entering the maxillary sinus through the canine fossa. It is a simple procedure and one gets a much better view than by other means. There is little reaction, general or local, and one can make a satisfactory opening into the inferior meatus without destruction of the inferior turbinate. I have long since discontinued trying to remove all mucosa from the maxillary sinus.

I should like to ask Dr Williams to speak on antihistamine drugs.

DR ROBERT H FRASER There is much sinus disease in Michigan, and people have to have something done I have been greatly helped by Dr Williams delineation of principles and by this rich presentation All are groping toward better understanding Selye and Williams have pursued the defects of adaptation as existent in both old and young

The surgical procedure which my associates and I follow consists of certain steps in the course of progressive screening processes In regard to the maxillary sinus the number of smears showing eosinophils is revealing, next comes roentgen examination and, if needed, diagnostic irrigation The more severe suppurations, even some of dental origin, seem, in my hands, to yield to irrigations in which 2 cc of a saline solution of penicillin (10,000 units per cubic centimeter) is used, given ordinarily at six day intervals until the mucosa is normal The empyema may be at an end, and in time its concomitant derangements, with the result that allergy succeeds further At this point iodized oil reveals such pedunculations (irreversible) as sway the selection of needed surgical intervention from an antral window to a canine fossa approach, or even to the Caldwell Luc operation I believe the necessity of surgical intervention must be faced, although the number of patients operated on in the twenties has been screened to the point of decimation—screened surgery becoming conservative surgery

With Dr Williams one must respect the problems of those cases of chronic frontal sinusitis which necessitate external operation with, perhaps, employment of the Riedl collapse type of obliteration I should like to recall the presentation of Dr W Likely Simpson, of the University of Tennessee College of Medicine, given before the Academy in October 1943 He has had a large and remarkably successful series through employment of the Lynch approach, which his presentation showed to lead to prompt and permanent healing, including obliteration of the cavity on the blood clot principle I can vouch for the preoperative data and for the satisfactory healing that occurred in a considerable number of his cases Credited as integral to the success are a number of Simpson requirements The elimination of mucoperiosteal remnants in the course of both the frontal sinusotomy and the complete exenteration of the adjacent ethmoid cells is precisely executed in steps which one might call "minute and meticulous" The operator works much under mirror check and through mirror vision within the sinus to achieve finished surfaces The newer detail includes a motor driven burr for irregularities The nasofrontal duct is entirely removed The middle turbinate is left intact Little packing is used and that only in the nasal fossa for twenty four to forty eight hours, after which no treatment is carried out except slight cleansing of the lumen of the nose The frontal cavity is not disturbed after operation With all the floor of the frontal sinus removed and an exenterated ethmoid labyrinth, the inferior aspect of the operative field is disregarded, with neither expansion nor constriction of whatever outlet is then present, granulations not being feared The sinus area is expected not to be reentered at any time Penicillin, since it has become available, is administered for seven or eight days, furthering the blood clot method, with successful organization of the clot, in order to obtain obliteration of the cavity I know of a case of an anteroposterior depth of 18 mm which, by this procedure, was managed without incident I am sure Dr Simpson has made valuable contributions which are capable of formulation and practical application

DR HENRY L WILLIAMS I do not know that a diagnosis of allergy is justifiable in every instance in which a large number of eosinophils are found in the mucosa on histologic examination The role of the eosinophil in allergy is not known Code and others have suggested that the eosinophil is the principal source of histamine, but I do not believe the finding of many eosinophils in the

nasal mucosa on microscopic examination unqualifiedly indicates that the patient has an allergic disease, in an occasional case there could be reasonable doubt. The histologic or the cytologic diagnosis of allergy cannot always be substantiated by a trial of routine allergic methods of treatment, or of antihistamine drugs, or of other nonspecific antiallergic treatment. It seems to me, therefore, that the mere presence of eosinophils in nasal smears or in histologic sections is insufficient evidence on which to base a diagnosis of allergy.

The same statement can be made about polypoid formation. Polyposis results when fluids escape from the blood vessels into the pericellular tissues and edema results. Where underlying tissue is deficient in fibrous and elastic elements, the edematous part is not supported, hangs down and forms a polyp, that is not hyperplasia. As Dr. Galloway has said, "in the occasional case when sufficient aeration and drainage are given" evidence of allergy disappears and the appearance of the nasal mucosa returns to normal. If one were an allergist, one might argue that bacterial allergy produced the polyps which disappeared on eradication of the infection. It is difficult to prove that hypothesis one way or the other.

It can be shown that allergic symptoms do not always demonstrate that a child is allergic. Children fed an abnormal diet sometimes have symptoms of vasomotor rhinitis which are not on an allergic basis. Dr. Arild Hansen, of Minneapolis, indicated the role of lack of unsaturated fatty acids in producing this symptom. The rhinitis sometimes clears up on administration of unsaturated fatty acids. If children eat fat meat, they will not have this type of nasal congestion, but if they will not eat it, a teaspoonful of lard mixed with sugar and spice given as candy three times a day will relieve the symptoms and give them their quota of fatty acids. Butter has a low iodine number and cannot be substituted. Corn oil is good. Edema of the nasal mucosa may be associated with a low basal metabolic rate in both adults and children, and oftentimes is the only symptom observed. The use of thyroid relieves the symptoms, which indicates, I think, that the symptoms are not allergic. I am not one of those who insist that the basis of all chronic suppuration in the sinuses is allergy.

In regard to operation on the frontal sinus, Dr. Van Alyea appears to be more conservative than I am when he advocates saving of the cells of the bulla ethmoidalis. I believe the easiest and best pathway to the frontal sinus by the intranasal route is through the bullar cells. I usually remove not only the bullar cells but those of the agger nasi as well, and enlarge the nasofrontal opening laterally, anteriorly and posteriorly. The floor of the frontal sinus should be removed to the septum and laterally as far as possible without breaking into the orbital tissue. In my experience this usually results in a permanent intranasal opening. My preference for the intranasal operation on the frontal sinus, when feasible, lies not so much in preserving the mucosal lining—that is important—but in preventing the collapse of the soft tissues which occurs when their support is removed as in the external procedure. Dr. Simpson advocates an external approach to the infected frontal sinus with removal of the frontal process of the superior maxillary nasal bone and the orbital plate of the ethmoid bone, much as the late Dr. Lynch did. I believe this widespread removal of bone in the entrance to the frontonasal opening is poor technic.

In regard to Dr. Van Alyea's proposal to preserve the frontal duct, I have not seen many cases in which the nasofrontal duct was not involved in disease of the frontal sinus. In many cases I have found constricting reactive osteitis in this region. In many cases pyocele does not seem to be due to infection of previous mucocele but is produced by bony growth constricting the nasofrontal openings. I do not mean to imply that pyocele never is a secondary result of mucocele but

that it is, I believe, in many instances the direct result of infection and the effect of this on the bone

Dr Van Alyea did not obtain good results from intranasal instillation of penicillin. I agree if instillation is done by the Proetz method once a day by the doctor. Instillation of 2 cc of a solution of penicillin into a sinus does not seem to accomplish more than lavage with isotonic solution of sodium chloride. The sinusitis of an occasional patient will appear to be cleared up by lavage with penicillin solution or even with saline solution. The results of instillation of penicillin solution can be improved if the patient applies it himself several times a day by Hymess's modification of the Proetz technic. The poor results from penicillin therapy in my experience were due to the fact that in order to secure therapeutic effect the solution of penicillin had to be maintained in contact with the mucosa for two or three hours. Apparently ciliary activity takes place even in the presence of serious disease, so that a solution introduced but once daily is removed before sufficient time has elapsed to produce a result. If the solution is introduced six or eight times a day by the patient himself, in certain instances a curative effect is produced. I do not say cure of patients is achieved in 100 per cent, but cure in as many as 10 per cent is a relatively good result.

By hyperplastic ethmoiditis I mean nasal disease in which allergy and infection are mingled. While it is true that, as Dr Van Alyea states, many polyps hanging in the nose do not originate in the ethmoid labyrinth, yet the cells in the ethmoid labyrinth are full of polypoid material. The postoperative application of radium, which tends to produce fibrosis, and therefore increases the supporting structure in the tissue, is beneficial. Radium is not curative but is worth while as it gives symptomatic relief and does tend to prevent recurrence after removal of polypoid tissue.

Dr Shapiro asked whether unilateral ablation of the frontal sinus can be achieved. I believe it can be done if care is taken to eradicate the mucosa from, and bevel the edges of, the frontal sinus as originally suggested by Lillie. Proof that the sinus never reforms is difficult to get because patients do not wish to submit to an examination unless symptoms recur. However, I have a patient who has been without symptoms for more than five years after this type of operation. It seems to me that the poor cosmetic result of ablation is not really an important consideration now that cosmetic procedures have improved. Furthermore, if a patient has been operated on several times with recurrence of infection after each procedure, he does not care how he looks if he can get rid of the infection, and for such a patient I think no other type of operation is indicated. After the infection has been absent for six months or a year, suitable reparative plastic work can be done. The coronal incision is valuable in an ablating procedure if the patient has not been operated on previously with resulting unsightly scarring. This incision gives more adequate exposure and allows better beveling of the superior and lateral bony margins of the sinus, so that no dead space remains. Ablating the mucosa of the sinus and then allowing fibrosis to destroy the lumen of the sinus, I believe, cannot be depended on to destroy the lumen. I have known cases in which secondary abscesses occurred in the center of the fibrous tissue, with considerable discomfort and pain. I think there are many failures with this technic.

Dr Salinger asked about indications for nasal antrostomy. I feel this operation should be carried out when infection in the antrum fails to clear up after one or two lavages or when a patient after so called cure with lavage has repeated recurrence of antral disease. If the presence of an infected root of a tooth is ex-



cluded, the patient gets prompt objective and symptomatic relief by nasal antrostomy. It is a satisfactory operation.

Dr. Mundt stated that he secured good results in chronic maxillary sinusitis with the Caldwell-Luc technic without removal of the lining mucosa. I think this is true. The approach I employ is different, but the end result is the same. If one is more skilled in the Caldwell-Luc technic and gets better results with it, I do not see why one should not use it. It is a little more extensive and requires longer hospitalization than some other procedures. Whether an intranasal window or a Caldwell-Luc approach is made, the end result depends on the adequacy of the window left behind.

Antihistaminic drugs merely give symptomatic relief, they are not a cure. As soon as administration is stopped the symptoms return. For that reason they are unsatisfactory as a rule, because allergy is a lifelong affliction. Good initial results are obtained from administration of 50 mg. four times a day of almost any antihistaminic drug. As soon as the edema of the nasal mucosa subsides, the polyps recede, unless secondary fibrosis of the polypoid tissue is present. After the maximal result is obtained, I decrease the dose gradually in an attempt to find the smallest possible dose that will give symptomatic relief. One reason for the failure of allergic therapy is the lack of recognition of physical allergy, for which the precipitating stimuli are changes in temperature, emotional storms, etc. Antihistaminic drugs are helpful temporarily, but a more important use for them is in rapid diagnosis of an allergic or pathergic condition.

Dr. Fraser spoke of the use of iodized poppyseed oil for diagnosis and of penicillin for treatment of chronic sinusitis. At the Mayo Clinic iodized oil was tried by Dr. Pattee for diagnostic purposes in a large group of patients who gave a history suggestive of sinusitis. Roentgenograms were made at intervals. Twenty-four hours after instillation of the oil there was tremendous swelling of the lining membrane of the sinus. Roentgenograms made after instillation of iodized oil did not appear to have much additional diagnostic value as compared with those made by the usual method.

The etiologic problem of the polyp originating in the antrum and coming into the nasal chamber through the natural ostium has not been solved. This type has a tendency to recur unless the mucosa at the site of origin is removed. Such a polyp occurs in a single antrum, the other paranasal sinuses do not show evidence of polyposis. A large choanal polyp protruding into the nasopharynx has been mistaken for nasopharyngeal fibroma. At the Mayo Clinic histologic study of these polyps and their mucosal attachments has not suggested a definite cause for their appearance, even though search has been made for a neoplastic tendency in the nasal mucosa.

## Book Reviews

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**Das akustische Trauma** By L. Ruedi and W. Furrer Price 26 Swiss francs Basel Switzerland S. Karger

This is a profound and enlightening study of the complex problem of acoustic trauma. The alliance between the otologist and the physicist proves its value throughout the monograph. The student of acoustic trauma obtains valuable information from the physical definitions, the noise spectrums, the oscillograph recordings, the pressure curves and the frequency analysis of explosions.

The biologic response of the ear was studied in clinical observations, animal experiments and histologic examinations of the ear. Two groups of aural traumas are described. The first group is composed of professional deafness, report trauma of small arms and blunt injuries of the head without fracture of the temporal bone. The symptom complexes of this series are similar in spite of the diversity of causes. Typical is the C 5 dip, in early cases it is the only finding, but later it widens to a broad perception type deafness.

In the second group are aural damages created by explosions of grenades, bombs and heavy artillery. Typical of the latter group is the extensive damage done to the ear drum and structures of the middle ear. Some of the middle ear deafness is reversible. The damage of the inner ear is permanent. The C-5 dip is not found, but vestibular dysfunction is frequent. Unusual is the author's observation of rupture of the basilar membrane and hemorrhage involving the perilymphatic spaces without rupture of the ear drum.

The experimental part centers around two otologic problems.

First, what are the pathologic changes in the ear due to explosions and what is the correlation with the function of the ear? Second, what is the origin of the C 5 dip?

Guinea pigs were exposed to acoustic trauma, and the effect on function was determined by the pinna reflex. The histologic alterations, which are clearly portrayed, were correlated with the functional results. Of interest is the fact that Reissner's membrane was seen to be mildly damaged. The authors show a great interest in the nature of the C-5 dip and offer a hydrodynamic hypothesis as an explanation. On the basis of Bekesy's concept of an eddy formed in the inner ear, they assume that the direction of the eddy changes with frequency. The shift from left turn to right turn occurs, in their opinion, at a place which is the representation of C 5. The influence of fatiguing tones was found to be different when the fatiguing tone was above or below 4096. The details of this interesting observation should be seen in the original.

A device protecting against acoustic trauma is described. The protection afforded by the ear defender is demonstrated on guinea pigs and on workers exposed to industrial noises.

A physiologist may criticize the use of the pinna reflex as an indicator of cochlear function. The use of conditioned reflexes would have been a superior, though much more complicated, method. There are 126 pictures, curves, audiograms and photomicrographs which, owing to their clear print and concise legends, contribute greatly to the understanding. This book is an excellent contribution.

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